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Dipartimento di Biologia
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Poelt J., 1969. *Bestimmungsschlüssel europäischer Flechten*. J. Cramer, Vaduz, 757 pp.

Trevisan R., Cappelletti E.M. & Caniato P., 1983. *Epicarp micro-characters in some european Angelica species*. Atti Accad. Naz. Lincei, Rend. Cl. Sci. fis., mat. e nat., 74: 77-82.

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SOBRE LAS COMUNIDADES DE LIQUENES CALCICOLAS DE ZONAS COSTERAS DEL SUR DE LA PENINSULA IBERICA Y MARRUECOS

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Keywords: Calcicolous, Coast, Lichens, Morocco, Portugal, Spain, Vegetation.

Abstract: ON THE CALCICOLOUS LICHEN COMMUNITIES FROM COASTAL AREAS OF THE SOUTHERN IBERIAN PENINSULA AND MOROCCO. The calcicolous lichen vegetation along the coasts of southern Spain, Portugal and Morocco was investigated. On the basis of the phytosociological approach the following associations and communities are recognized: *Caloplacetum subochraceae*, *Verrucarietum cazzae*, community of *Solenopsora cesatii* and *S. olivacea* var. *olivacea*, community of *Rinodina immersa*, community of *Aspicilia calcarea* and *Xanthoria calcicola*, *Dirinetum repandae*, *Opegraphetum durieui*, community of *Heppia solerinoides* and *Psora vallestica*, community of *Xanthoria resendei* and community of *Caloplaca xantholyta* and *Lepraria nivalis*. The ecology, distribution and floristic composition of all syntaxonomic units are discussed.

Introducción

El análisis de la vegetación líquénica del sureste de España se inició, hace más de una década, con un amplio estudio de los líquenes que pueblan las rocas ácidas (silíceas o volcánicas) del SE de España. Como resultado de estos estudios se pueden citar las aportaciones realizadas por Egea & Llimona (1982, 1984, 1987, 1991) y Llimona & Egea (1984, 1985).

En este artículo se sintetizan los resultados obtenidos hasta la fecha sobre las comunidades líquénicas calcícolas, detectadas en nuestro área de estudio (Fig. 1, Tabla 1). El análisis se inició, hace unos años con un primer esbozo de las rocas calizas del litoral del SE de España (Alonso 1987). Al mismo tiempo, y como una primera aproximación a los líquenes terrícolas, se comentan una serie de inventarios, insuficientes en número para establecer con exactitud la asociación que determinan.

Los antecedentes que disponemos sobre comunidades de rocas calizas, tanto en la zona de estudio como en el resto de la Península Ibérica y Baleares, son más bien escasos. Klement (1965) es el primero en mencionar algunas comunidades calcícolas de Baleares. Roux (1978), en su estudio

sobre las poblaciones calcícolas del SE de Francia, presenta algunos inventarios tomados en Cataluña (Lérida y Figueras), Levante (Denia y Calpe), Algarve (Budens) y Estremadura (Sesimbra y Obidos).

Merino (1981) realiza un estudio de las calizas del sureste de Madrid, en donde indica la presencia de algunas comunidades líquénicas. Casares (1984) y Casares & Llimona (1986) realizan un completo estudio sobre las calizas de Sierra Nevada, centrado sobre todo en zonas de gran altitud. Por otro lado, Egea & Llimona (1984) inician una primera aproximación sobre las comunidades ombrófilas de las costas de Alicante, Murcia y Almería.

A estas aportaciones, hay que añadir los trabajos realizados por Boqueras *et al.* (1989), sobre la flora y la vegetación líquénica nitrófila del Delta del Ebro; Baeza (1989), sobre líquenes calcícolas de Sierra Espuña (Murcia); Egea (1989) sobre las comunidades ombrófilas del suroeste de Europa y norte de África y Roux & Egea (1992) sobre la asociación *Opegraphetum durieui* en la Región Mediterránea.

Por último, Moreno & Egea (1991a,b), en su

estudio de la familia Lichinaceae en el SE de la Península Ibérica y N de Africa, realizan un amplio comentario sobre las comunidades de escorrentia.

Datos y Métodos

La descripción de las comunidades que se detallan a continuación, se basa en la bibliografía consultada y en los datos de los inventarios tomados con la metodología sigmatista, adaptado por Klement (1955).

La recolección de los ejemplares de las áreas inventariadas, se ha realizado siguiendo el método de "prélèvement partiel", puesto a punto por Clauzade & Roux (1975) y discutido posteriormente por Roux (1991). En el cálculo de los parámetros sintéticos se han utilizado los índices propuestos por Boudouresque (1970, 1971), aplicados y descritos por Clauzade & Roux (1975), Roux (1978), Casares & Llimona (1986) y Egea & Llimona (1987). Estos parámetros cuantifican las diferencias entre los distintos grupos de especies que componen la asociación, indicando al mismo tiempo su grado de adaptación al medio. En los trabajos anteriormente citados puede encontrarse también el significado de los diversos símbolos y abreviaturas utilizadas en el texto. Para la nomenclatura hemos seguido las siguientes obras: Clauzade & Roux (1985), Purvis *et al.* (1992) y Nimis (1993).

A continuación se expone el catálogo descriptivo de las comunidades observadas, donde se incluyen, de forma general, los siguientes apartados: ecología, distribución, fisionomía, composición florística, tabla de inventarios y tabla de parámetros sintéticos.

ESQUEMA SINTAXONOMICO

Clase provis. *Protoblastenietea immersae* Roux 1978

Orden provis. *Verrucarietalia parmigeriae* Roux 1978

Alianza *Verrucarion sphinctrinellae* Roux 1978
Ass. *Caloplacetum subochraceae* (Clauzade & Roux 1975) em. Roux 1978

Ass. *Verrucarietum cazzae* Clauzade & Roux 1975

Comunidad de *Solenopsora cesatii* y *S. olivacea* var. *olivacea*.

Alianza *Rinodinion immersae* Roux 1978

Comunidad de *Rinodina immersa*

Clase *Verrucarietea nigrescentis* Wirth 1980

Orden *Verrucarietalia* Klement 1950

Alianza *Aspicilion calcareae* Albertson 1946 ex Roux 1978

Comunidad de *Aspicilia calcarea* y *Xanthoria calcicola*

Clase provis. *Roccelletea phycopsis* Egea 1989

Orden provis. *Dirinetalia massiliensis* Egea 1989

Alianza *Roccellion phycopsis* Egea & Llimona em. Egea 1989

As. *Dirinetum repandae* Clauzade & Roux 1975

As. *Opegraphetum durieui* Egea & Roux 1992

Clase *Psoretea decipiens* Mattick em. Crespo & Barreno 1975

Orden *Fulgensietalia desertori* Crespo & Barreno 1975

Alianza *Psorion saviczii* Crespo & Barreno 1975

Comunidad de *Heppia solerinoides* y *Psora vallesiaca*

Comunidad de *Xanthoria resendei*

Comunidad de *Caloplaca xantholyta* y *Lepraria nivalis*

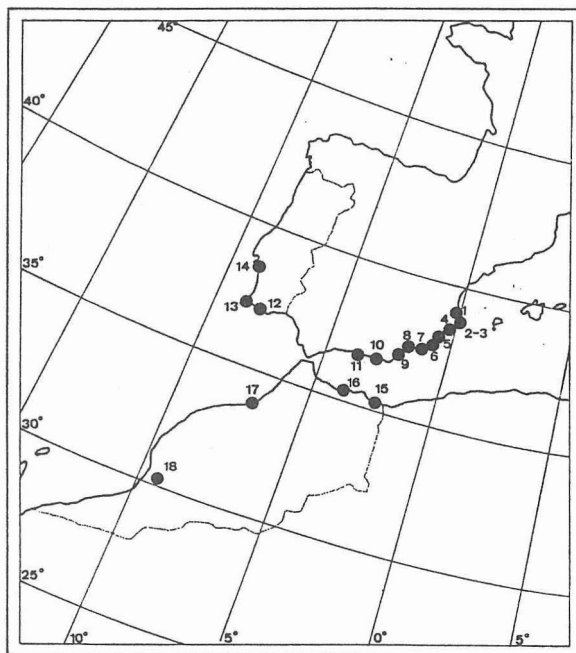


Fig. 1 - Localidades estudiadas.
Location of the stations.

- Comunidades de Líquenes calcícolas de zonas costeras Ibérica -

Tab. 1 - Localidades estudiadas.

List of localities.

Tm: Termomediterráneo; Im: Inframediterráneo; R-Q: *Rubio-Quercetum rotundifoliae*; Q-P: *Quercus-Pistacietum lentisci*; C-R: *Chamaeropo-Rhamnetum lycioideis*; A-T: *Arisaro-Tetraclinietum articulatae*; M-P: *Mayteno-Periplocetum angustifoliae*; Z: *Ziziphietum loti*; Z-M: *Zizipho-Maytenetum europaei*; S-Q: *Smilaci-Quercetum rotundifoliae*; Q-J: *Quercus-Juniperetum turbinatae*; V-Q: *Viburno-Quercetum cocciferae*; P-T: *Periploco-Tetraclinietum articulatae*; C-J: *Clematidi-Juniperetum lyciae*; E-A: *Euphorbio echini* - *Arganietum spinosae*.

Nº	Localidades	Altura (m)	Piso bio- climático	Ombroclima	Vegetación potencial	UTM
ESPAÑA						
1	Alicante, Denia:					
	- Sierra del Montgó	350	Tm	seco	R-Q	BD4900
	- Torre del Charro	100	Tm	seco	R-Q	BD5301
2	Alicante, Jávea:					
	- Cabo de San Antonio	180	Tm	seco	R-Q	BC5799
	- Cabo de La Nao	170	Tm	seco	R-Q	BC5991
3	Alicante, Calpe:					
	- Peñón de Ifach	150	Tm	seco	R-Q	BC4580
	- Morro del Toix	100	Tm	seco	R-Q	BC4180
4	Alicante:					
	- Benidorm, Sa. Helada	200	Tm	semiárido	Q-P	YH5369
	- Villajoyosa, Playa Paraís	30	Tm	semiárido	Q-P	YH4065
5	Alicante: Santa Pola, Faro	120	Tm	semiárido	C-R	YH1832
6	Murcia, Cabo de Palos:					
	- Faro	10	Tm	semiárido	C-R	YG0386
	- Cala Reona	10	Tm	semiárido	C-R	YG0165
	- Monte de las Cenizas	330	Tm	semiárido	A-T	XG9261
7	Murcia, Cartagena:					
	- Sa. Muela, Cabezo Colorado	350	Tm	semiárido	M-P	XG6861
	- Cabo Tiñoso, La Picadera	250	Tm	semiárido	M-P	XG6457
	- Cedacero, Cabezo El Cambrón	350	Tm	semiárido	M-P	XG6361
	- Punta La Azohía	50	Tm	semiárido	M-P	XG6258
8	Murcia:					
	- Mazarrón, Bolnuevo	200	Tm	semiárido	Z	XG4960
	- Aguilas, Cabo Cope	150	Tm	semiárido	M-P	XG3443
	- Pulpí, Cala Reona	20	Tm	semiárido	Z	XG2138
9	Almería:					
	- Turre, Sa. Cabrera	250	Tm	semiárido	Z	WG9507
	- Carboneras, Punta Muertos	100	Tm	semiárido	M-P	WF9990
10	Almería, inmediaciones Puente del Cura	80	Tm	semiárido	Z-M	WF7643
11	Granada, Almuñécar:					
	- Punta de la Mona	120	Tm	seco	S-Q	VF6535
	- Cerro Gordo	250	Tm	seco	S-Q	VF6530
PORTUGAL						
12	Algarve, Lagoa, Cabo Carboeiro	20	Tm	seco	S-Q	-
13	Algarve, Sagres:					
	- Punta de Sagre	50	Tm	seco	Q-J	-
	- Cabo San Vicente	80	Tm	seco	Q-J	-
14	Estremadura, Setúbal, Castillo de Sesimbra	150	Tm	subhúmedo	V-Q	-
MARRUECOS						
15	Ras-El-Mara, Cap de l'eau	30	Tm	semiárido	P-T	-
16	Al-Hoceima, Ctra. costera	10	Tm	seco	P-T	-
17	Rabat, Témara Plage	50	Tm	seco	C-J	-
18	Mirhleft, entre Gourizim y Mirhleft (5 km antes)	10	Im	semiárido	E-A	-

Resultados

Clase provisional *Protoblastenietea immersae* Roux 1978

Incluye a comunidades líquénicas saxícolas poco o nada nitrófilas, constituidas, en gran parte, por líquenes de talos endolíticos que se desarrollan sobre rocas básicas duras y generalmente compactas, en las Regiones Mediterránea y Eurosiberiana. Se encuentran desde el piso termomediterráneo al crioromediterráneo y desde el piso colino al alpino.

Las especies características de esta clase, designadas por Roux (1978), que quedan incluidas en nuestros inventarios son: *Clauzadea immersa*, *C. monticola* y *Protoblastenia rupestris*, las cuales poseen una gran amplitud climática.

De los dos órdenes descritos para esta clase, sólo el orden *Verrucarietalia parmigerarum* Roux 1978 ord. prov. se encuentra representado en el litoral de nuestro área de estudio. El otro orden, *Thelidietalia decipientis* Roux 1978 ord. prov., queda restringido a zonas de clima frío (pisos subalpino y alpino) de la Región Eurosiberiana.

Orden provisional *Verrucarietalia parmigerarum* Roux 1978

Incluye las asociaciones de líquenes endolíticos, poco o nada nitrófilas.

Entre las especies características de este orden, bien representadas en los inventarios realizados, se han identificado: *Aspicilia coronata*, *Caloplaca alociza*, *C. ochracea*, *Catillaria lenticularis*, *Opegrapha rupestris*, *Porina linearis*, *Staurothele immersa* y *Verrucaria baldensis*.

En este orden se agrupan tres alianzas: *Verrucarion sphinctrinellae*, *Rinodinion immersae* y *Acrocordion conoideae*. Las dos primeras se extienden por los pisos bioclimáticos termo y mesomediterráneo. La tercera tiene su óptimo en el piso mesomediterráneo.

Alianza *Verrucarion sphinctrinellae* Roux 1978

Reune a comunidades saxícolas, calcícolas, que se instalan en superficies más o menos inclinadas hasta verticales, encaradas al N o al W y no expuestas a los vientos dominantes. Se la puede definir como ombrófila, más o menos fotófila hasta esciófila y termófila.

Según Roux (1978), son especies características de esta alianza: *Verrucaria parmigerella*, *Opegrapha calcarea*, *Caloplaca tenuatula* ssp. *inconnexa* y *Solenopsora cesatii*. Todas ellas se

encuentran en el litoral, si bien, *Verrucaria parmigerella* y *Opegrapha calcarea* están representadas de forma frecuente en los inventarios. *Caloplaca tenuatula* ssp. *inconnexa* es muy poco frecuente y *Solenopsora cesatii* forma una comunidad, en el SE español, con *Solenopsora olivacea* de la que trataremos posteriormente.

Asociación *Caloplacetum subochraceae* (Clauzade & Roux 1975) em. Roux 1978

Ecología: Coloniza las rocas calcáreas duras y compactas o un poco margosas, en zonas no muy alejadas del mar. Se instala en las superficies más o menos inclinadas hasta verticales, iluminadas pero poco soleadas, por lo que conservan largo tiempo la humedad nocturna. Pueden recibir precipitaciones directas, pero están más o menos protegidas de los vientos dominantes. Se trata, pues, de una asociación fuertemente termófila, fotófila, heliófoba, más o menos ombrófila y heminitrófila.

Distribución: De acuerdo con Roux (1978), la asociación se encuentra en puntos aislados del litoral de la Región Mediterránea, desde el SE de Francia (Provenza) hasta Estremadura, en Portugal. En el E y SE de la Península Ibérica, se encuentra muy bien desarrollada en puntos de la provincia corológica Murciano-Almeriense, en sus sectores alicantino y murciano. En Portugal, aunque se ha detectado su presencia, se encuentra muy empobrecida. Roux (o. c.) presenta tres inventarios del Algarve y Estremadura portuguesa en los que domina *Caloplaca subochracea* var. *subochracea* en ambientes relativamente esciófilos. En Marruecos, *Caloplaca subochracea* var. *luteococcinea*, sólo ha sido recolectada de una localidad (Al-Hoceima), también con un índice de abundancia-dominancia muy bajo. La especie tipo es más abundante en el Rif occidental (Ceuta y Tetuán, Werner 1932 y 1979).

La asociación encuentra su óptimo en el dominio del *Rubio-Quercetum rotundifoliae* y *Mayteno-Periplocetum angustifoliae*. Puede considerarse como la vicariante de la asociación *Pertusarietum gallicae* Llimona & Egea 1984, descrita del SE de España sobre rocas ácidas.

Fisionomía: La comunidad está dominada por talos crustáceos, epilíticos, aunque no son raros los talos de tipo endolítico como *Topelia heterospora*, *Verrucaria calciseda* y *V. baldensis*. Destaca por las grandes manchas de color amarillo anaranjado *Caloplaca subochracea* var. *luteococcinea* (DR = 71.47 %). Alternando con ésta, son frecuentes las

- Comunidades de Líquenes calcícolas de zonas costeras Ibérica -

Tab. 2 - Asociación *Caloplacetum subochraceae*
Caloplacetum subochraceae association

Nº de orden	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Altitud (m)	300	100	75	75	150	170	200	300	170	170	75	160	160	150	150			
Superficie (dm ²)	150	100	200	150	60	30	100	100	70	150	100	150	100	150	100			
Orientación	N	NW	N	N	NE	NE	N	N	NE	NE	N	NE	N	N	NE			
Inclinación (°)	90	80	80	70	70	75	85	85	45	40	85	40	120	85	60			
Recubrimiento (%)	95	100	100	100	100	95	95	95	100	100	95	100	100	95	100			
Nº de especies	14	18	16	15	15	16	15	18	14	16	17	21	16	15	17			
Características de la asociación																		
<i>Caloplaca subochracea</i> v. <i>luteococcinea</i>	3.3	3.3	3.3	1.2	3.4	2.2	3.3	3.3	2.3	3.3	3.3	2.3	3.3	3.4	3.3	V	30.67	71.74
<i>Solenopsora olivacea</i> v. <i>olivacea</i>	1.1	1.1	+	1.1	+	+	+	+								III	0.53	1.24
<i>Topelia heterospora</i>	1.1	1.1	+	+	2.2	1.1										II	1.51	3.53
Características de la alianza																		
Verrucarion sphinctrinellae																		
<i>Verrucaria parmigerella</i>	1.1	+	+	3.3	+	+			1.1	+		+	+			IV	2.88	6.74
<i>Opegrapha calcarea</i>	+	+	+	+		+			+	1.1						III	0.21	0.49
<i>Solenopsora cesatii</i>	+		+		+							+				II	0.03	0.07
Características del orden																		
Verrucarietalia parmigerarum																		
<i>Catillaria lenticularis</i>	+	+	+		+	+		+		+	+	+	+	+	+	IV	0.08	0.18
<i>Porina linearis</i>	+	+	+	+		2.2	+	+		+	+	+		1.1		IV	1.23	2.87
<i>Verrucaria calcisceda</i>		+	1.1	+	1.1				1.1	1.2						III	0.69	1.61
<i>Verrucaria baldensis</i>	1.1	+	+	+	+	+				+						III	0.21	0.49
<i>Caloplaca alociza</i>	+	+		+	+	+			+	+						III	0.05	0.12
<i>Aspicilia coronata</i>	+								+	2.2	+					II	1.02	2.39
<i>Opegrapha rupestris</i>							+		+				+			I	0.02	0.05
Características de la clase																		
Protoblastenietea immersae																		
<i>Clauzadea monticola</i>		+		+	+		+	+				1.1		+		III	0.21	0.49
Transgresivas de la asociación																		
Dirinetum repandae																		
<i>Dirina massiliensis</i> f. <i>sorediata</i>		1.1	1.1		1.1	+	1.1	+	1.2	+	1.1	+	1.1	+	+	V	0.16	0.37
<i>Dirina massiliensis</i> f. <i>massiliensis</i>	+						1.1		+		+		1.1	+	+	II	0.39	0.91
<i>Roccella phycopsis</i>													+			I	0.01	0.02
Acompañantes																		
<i>Caloplaca aurantia</i>		+	+		+	+			1.1	1.1	1.1	1.1	+	+		IV	0.71	1.66
<i>Buellia epipolia</i> v. <i>epipolia</i>			+		+	+		+	1.1	+	+	+	+	+	+	IV	0.23	0.54
<i>Verrucaria nigrescens</i>		+				+	+	+	+	+		1.1	+	+	+	IV	0.23	0.54
<i>Xanthoria calcicola</i>		+	+	1.1	+			+			+		+	1.2	+	III	0.38	0.89
<i>Aspicilia calcarea</i>		1.1		+	1.1	+		+		1.1				+		III	0.53	1.24
<i>Lecanora albescens</i>								+			+	+	+	+	+	II	0.04	0.09
<i>Caloplaca flavescens</i>	+						+	1.1			+	+		+		II	0.20	0.47
<i>Catillaria chalybeia</i>							+	+			+			+		II	0.03	0.07
<i>Buellia</i> sp.							+	+			+			+	+	II	0.03	0.07
<i>Caloplaca variabilis</i> f. <i>chalybaea</i>		+	+						+	+		+		+		II	0.03	0.07
<i>Caloplaca variabilis</i> f. <i>paepalostoma</i>												+	+	+	+	II	0.03	0.07
<i>Caloplaca variabilis</i> f. <i>variabilis</i>											+	+	+	+		II	0.03	0.07
<i>Toninia episema</i>		+		+	+	+										II	0.03	0.07
<i>Solenopsora candicans</i>							+	+				+		+		II	0.03	0.07
<i>Verrucaria glaucina</i>							+	+				+		+		II	0.03	0.07
<i>Aspicilia contorta</i>											+	1.1	+	+		II	0.19	0.44
<i>Lecanora campestris</i>											+			+		I	0.01	0.02
<i>Toninia aromatica</i>								+						+		I	0.01	0.02
<i>Caloplaca tenuatula</i> v. <i>lithophila</i>									+	+						I	0.01	0.02
<i>Caloplaca velana</i> v. <i>schaereri</i>							+					+				I	0.01	0.02
<i>Verrucaria lecidoides</i>												+			+	I	0.01	0.02
<i>Lithothelium triseptatum</i>				+	+											I	0.01	0.02
<i>Candelariella aurella</i>													+		+	I	0.01	0.02
<i>Candelariella oleaginascens</i>							+	+								I	0.01	0.02
<i>Caloplaca concinerascens</i>											+					I	0.01	0.02
<i>Caloplaca conversa</i>														+		I	0.01	0.02

manchas de color grisáceo de *Dirina massiliensis* y *D. massiliensis* f. *sorediata* (DR = 1.88 %).

Composición florística (Tablas 2 y 3):

a. Características de la asociación: De acuerdo con Roux (1978) las características de la asociación son:

Caloplaca subochracea var. *luteococcinea*

Caloplaca subochracea var. *subochracea*

Solenopsora olivacea var. *olivacea*

Petractis luetkemulleri

Topelia heterospora

?*Lecanora agardhiana* ssp. *catalaunica*

?*Porina oleriana*

?*Porina linearis* var. *persicina*

Tab. 3 - Parámetros sintéticos del *Caloplacetum subochraceae*. Número de inventarios: 15; número total de especies: 43; número medio de especies por inventario: 16.2; RMG del conjunto de especies inventariadas: 42.75 %.

Synthetic data of the Caloplacetum subochraceae. Number of releves: 15; total number of species: 43; mean number of species in the releves: 16.2; global mean cover of the species: 42.75 %.

	RMG%	DR %	Q	DQ %	Ψ	
Características de:						
Asociación	32.71	76.51	1.93	11.91	6.42	Gr. esp. bien adapt.
Al. Verrucarion sphinctrinellae	3.12	7.30	1.40	8.64	0.84	Gr. esp. +/- adapt.
Ord. Verrucarietalia parmigeriae	3.30	7.71	3.40	20.98	0.36	Gr. esp. mal adapt.
Cl. Protoblastenietea immersae	0.21	0.49	0.47	2.90	0.17	Gr. esp. mal adapt.
Transgresivas As. Dirinetum repandae	0.56	1.30	1.33	8.21	0.16	Gr. esp. mal adapt.
Acompañantes	2.85	7.41	7.60	46.91	0.16	Gr. esp. mal adapt.

Los táxones mejor representados, según su Dominancia cuantitativa (DR) y en orden decreciente, son: *Caloplaca subochracea* var. *luteococcinea*, *Topelia heterospora* y *Solenopsora olivacea* var. *olivacea*. En conjunto, los tres táxones poseen un DR = 76.51 % y una fuerte tensión ($\Psi = 6.42$).

Si tenemos en cuenta la tabla dada por Roux (1978) en la descripción de esta asociación y la comparamos con nuestra tabla de inventarios, observamos que:

- *Caloplaca subochracea* var. *subochracea*, *Porina oleriana*, *Petractis luetkemulleri* y *Lecanora agardhiana* ssp. *catalaunica* no están representados en ninguno de los inventarios que forman parte de la tabla fitosociológica.

- Según nuestras observaciones, *Solenopsora olivacea* var. *olivacea* (DR = 1.24 %), en el litoral del SE español, está más ligado a la comunidad que comentaremos a continuación que a esta asociación.

b. *Características de unidades superiores*: Forman un conjunto de especies con una presencia relativamente alta, pero poco adaptadas a las condiciones de la comunidad, como lo demuestra los índices de tensión de cada una de estas unidades superiores. *Verrucaria parmigerella* y *Opegrapha calcarea* (DR = 7.3 %) son las especies mejor representadas de la alianza *Verrucarion sphinctrinellae* Clauzade & Roux 1975.

Las especies que componen el orden *Verrucarietalia parmigeriae*, están bastante mal adaptadas (DR = 7.71 %, $\Psi = 0.36$) y únicamente

Porina linearis, *Verrucaria calciseda*, *Verrucaria parmigera* y *Aspicilia coronata* poseen, en algunos casos, índice de abundancia-dominancia de 1 ó 2. El resto de especies, como: *Catillaria lenticularis*, *Verrucaria baldensis*, *Caloplaca alociza* y *Opegrapha rupestris*, tienen una importancia nula o insignificante.

La clase provisional *Protoblastenietea immersae* sólo está representada por *Clauzadea monticola* que, al igual que las especies del orden, está bastante mal adaptada (DR = 0.49 %, $\Psi = 0.17$).

c. *Transgresivas*: En zonas más resguardadas de la lluvia y donde la humedad atmosférica es relativamente elevada, son frecuentes las especies transgresivas de la asociación *Dirinetum repandae*: *Dirina massiliensis* y *D. massiliensis* f. *sorediata* principalmente, que forman un grupo muy mal adaptado (DR = 13 %, $\Psi = 0.16$).

Asociación *Verrucarietum cazzae* Clauzade & Roux 1975

Ecología: Coloniza las rocas calcáreas duras y compactas, poco o nada margosas, en zonas poco alejadas del mar. Se instala en superficies más o menos inclinadas o verticales, bastante iluminadas pero poco soleadas, que reciben precipitación directa, aunque se secan muy rápidamente después de cesar las lluvias. En lugares muy iluminados la comunidad tiende a situarse en paredes verticales.

Distribución: La asociación encuentra su óptimo en el piso mesomediterráneo de la Región Mediterránea francesa, en el dominio de la asociación *Quercetum ilicis* (Clauzade & Roux

Tab. 4 - Asociación *Verrucarietum cazzae*.
Verrucarietum cazzae association.

Nº de orden	1	2	3	4	5			
Altitud (m)	350	500	100	100	100			
Superficie (dm ²)	60	200	200	150	100			
Orientación	N	NE	NE	NE	NE			
Inclinación (°)	60	80	85	70	60			
Recubrimiento (%)	55	100	90	90	80			
Nº de especies	19	18	20	13	15			
Características de la asociación								
Verrucaria cazzae	3.3	2.2	1.1	1.1	1.1	V	12.00	22.45
Características de la alianza								
Verrucarion sphinctrinellae								
Verrucaria parmigerella	1.1	3.3	3.3	2.2	1.1	V	19.00	35.55
Solenopsora cesatii	1.1	+	1.1			III	1.02	1.91
Opegrapha calcarea	+	+	+			III	0.06	0.11
Características del orden								
Verrucarietalia parmigerae								
Caloplaca alociza	1.1	1.1	1.1	+	2.2	V	4.52	8.46
Aspicilia coronata	1.1	+	+	1.1	1.1	V	1.54	2.88
Verrucaria baldensis	1.1	1.1	1.1	1.1	+	V	2.02	3.78
Staurothele immersa	+	+	+	+	+	V	0.10	0.18
Porina linearis	1.1	+	1.1			III	1.02	1.91
Opegrapha rupestris			+			I	0.02	0.03
Características de la clase								
Protoblastenietea immersae								
Clauzadea immersa	+	+	1.1	1.1	+	V	1.06	1.98
Características de la alianza								
Rinodinium immersae								
Caloplaca agardhiana	1.1	1.1	+	+	2.2	V	4.04	7.56
Rinodina immersa	+	+		+	+	IV	0.08	0.15
Transgresivas de la alianza								
Acrocordion conoideae								
Acrocordia conoidea	+	1.1	1.1			III	1.02	1.91
Transgresivas de la alianza								
Aspicilion calcareae								
Buellia epipolia v. epipolia	+	+		+		III	0.06	0.11
Aspicilia calcarea			+			I	0.02	0.03
Toninia episema			+			I	0.02	0.03
Transgresivas de la clase								
Verrucarietia nigrescentis								
Verrucaria calciseda	2.2	1.1	1.1	1.1	1.1	V	5.00	9.36
Verrucaria nigrescens	+	+	1.1	+	+	V	0.58	1.08
Acompañantes								
Caloplaca conversa				+	+	II	0.04	0.07
Caloplaca tavaresiana			+		+	II	0.04	0.07
Lecania turicensis	+	+				II	0.04	0.07
Caloplaca velana v. schaereri	+	+				II	0.04	0.07
Hymenelia similis					+	I	0.02	0.03
Caloplaca tenuatula v. lithophila				+		I	0.02	0.03
Caloplaca aurantia			+			I	0.02	0.03
Petractis luetkemuelleri			+			I	0.02	0.03
Verrucaria sp.	+					I	0.02	0.03

1975). En nuestra zona de estudio aparece de forma puntual en el Levante español, en el dominio del *Rubio-Quercetum rotundifoliae*, con ombroclima

seco-húmedo y de forma muy poco representativa, como lo demuestra los coeficientes, más bien bajos, de los índices de abundancia-dominancia y

de sociabilidad. *Verrucaria cazzae* se conoce también en diversos puntos del mediterráneo (Poelt & Vězda 1981, Roux 1991), por lo que la asociación *Verrucarietum cazzae* podría estar ampliamente representada en la Región Mediterránea, desde Portugal a Yugoslavia (Roux 1991).

Puede considerarse como la vicariante altitudinal de la asociación *Caloplacetum subochraceae*, conocida del litoral mediterráneo de la Península Ibérica y SE de Francia.

Fisionomía: La comunidad está dominada por talos endolíticos de *Verrucaria cazzae*, *V. parmigerella*, *V. calciseda*, *Caloplaca alociza* y *C. agardhiana*. Algunas de estas especies, particularmente *V. cazzae* y *V. parmigerella*, destacan por sus talos de colores rosado y gris azulado, respectivamente, los cuales son mucho más intensos en estado húmedo, lo que permite visualizar rápidamente la asociación. Estas dos especies y *Verrucaria calciseda*, de talo blanco-grisáceo, representan un recubrimiento medio del 36 %. Si tenemos en cuenta que el recubrimiento total es de 53.46 %, ello supone que las especies anteriormente citadas representan el 67.34 % del recubrimiento total.

Por otro lado, las especies con talo crustáceo epilítico y talo placodiomorfo poseen escasa representación. De este grupo destaca, por su color verde-blanquecino, *Solenopsora cesatii*.

Composición florística (Tablas 4 y 5):

a. *Características de la asociación:* Clauzade & Roux (1975) señalan, como especies características de la asociación a: *Verrucaria cazzae*, *Buellia dubyanoides*, *Caloplaca oasis*, *C. inconnexa* v. *verrucariarum*, *Solenopsora candicans* y *S. olivacea*. Roux (1978), establece una forma empobrecida de esta asociación, denominada *Verrucarietum cazzae* septentrional, caracterizada por la presencia de *Caloplaca oasis* f. *rohlena*, la ausencia total de *Verrucaria cazzae* y la abundancia de *V. parmigerella*.

Nuestros inventarios corresponden a la forma tipo, aunque empobrecida, en la que *Verrucaria cazzae* presenta índices de abundancia-dominancia relativamente bajos (tan solo destaca el valor del inventario número uno), pero con índices elevados de dominancia cuantitativa (DR = 22.45 %) y tensión (Ψ = 3.86), lo que determina su excelente adaptación.

b. *Características de unidades superiores:* Las características de la alianza *Verrucarion sphinctrinellae* están bien representadas (DR = 37.57 %; Ψ = 2.94) debido a la dominancia de *Verrucaria parmigerella*. En cambio, las otras características (*Solenopsora cesatii* y *Opegrapha calcarea*) están mal representadas.

El orden provisional *Verrucarietalia parmigerarum*, aunque está representado por un elevado número de táxones, constituyen un grupo

Tab. 5 - Parámetros sintéticos del *Verrucarietum cazzae*. Número de inventarios: 5; número total de especies: 28; número medio de especies por inventario: 17; RMG del conjunto de especies inventariadas: 53.44 %.

Synthetic data of the Verrucarietum cazzae association. Number of relevés: 5; total number of species: 28; mean number of species in the relevés: 17; global mean cover of the species: 42.75 %.

	RMG%	DR %	Q	DQ %	Ψ	
Características de:						
Asociación	12.00	22.45	1.0	5.81	3.86	Gr. esp. bien adapt.
Al. Verrucarion sphinctrinellae	20.08	37.57	2.2	12.79	2.94	Gr. esp. bien adapt.
Ord. Verrucarietalia parmigerarum	9.22	17.24	4.8	17.90	0.62	Gr. esp. mal adapt.
Cl. Protoblastenietea immersae	1.06	1.98	1.0	5.81	0.34	Gr. esp. mal adapt.
Transgresivas:						
Al. Acrocordion conoideae	1.02	1.91	0.6	3.49	0.55	Gr. esp. inadapt.
Al. Rinodinion immersae	4.12	7.71	1.8	10.46	10.46	Gr. esp. inadapt.
Al. Aspicilion calcareae	0.10	0.17	1.0	5.81	0.03	Gr. esp. inadapt.
Cl. Verrucarietalia nigrescentis	5.58	10.44	2.0	11.62	0.90	Gr. esp. +/- adapt.
Acompañantes	0.26	0.43	2.8	16.28	0.03	Gr. esp. inadapt.

de especies poco adaptado ($DR = 17.24 \%$; $\Psi = 0.62$). Destaca *Caloplaca alociza*, con $DR = 8.46 \%$, lo que determina el 49 % del conjunto de esta unidad.

La clase provisional *Protoblastenietea immersae* está únicamente representada por *Clauzadea immersa* que, aunque el grado de presencia es de V, posee un valor de tensión bajo ($\Psi = 0.34$), lo que determina que esté muy mal adaptada.

c. *Transgresivas*: En la asociación se encuentran representados distintos grupos de especies, más o menos inadaptados, que proceden de unidades más esciáfilas (*Acrocordion conoideae*: $DR = 1.91 \%$; $\Psi = 0.55$), más fotófilas (*Rinodinion immersae*: $DR = 7.71 \%$; $\Psi = 0.74$) o más nitrófilas (*Aspicilion calcareae*: $DR = 0.17 \%$; $\Psi = 0.03$ y, sobre todo, *Verrucarietia nigrescentis*: $DR = 10.44 \%$; $\Psi = 0.90$).

Comunidad de *Solenopsora cesatii* y *Solenopsora olivacea* var. *olivacea*

Ecología: Comunidad litoral que coloniza la base de grandes paredones calizos duros o un poco margosos, así como los escalones rocosos, donde se acumulan materiales pulverulentos, frecuentemente humedecidos por agua de escorrentía que tiende a acumular materia orgánica y sales nutritivas. Prefiere las superficies más o menos inclinadas hasta verticales, poco o nada soleadas.

Distribución: Localizada hasta la fecha en la Sierra del Montgó (Denia), en el dominio climático de la asociación *Rubio-Quercetum rotundifoliae* y en la Sierra de la Muela y Cabo Tiñoso (Cartagena) y Cabo Cope (Aguilas) en el dominio de la asociación *Mayteno-Periplocetum angustifoliae*.

Fisionomía: Comunidad dominada por talos crustáceos, epilíticos, en gran parte areolado-lobulados. No son raros los táxones de talo endolítico como *Verrucaria parmigerella*, *Verrucaria baldensis* y *Porina linearis*. Se caracteriza por sus manchas más o menos extensas de color verde oliváceo de *Solenopsora olivacea*, gris verdosa de *Solenopsora cesatii* y negro de *Placynthium nigrum*.

Composición florística (Tablas 6 y 7):

a. *Características de la comunidad*: Consideramos como características y diferenciales de la comunidad los siguientes táxones:

- *Solenopsora cesatii*: Es una especie incluida por Clauzade & Roux (1975) entre las características de la alianza *Verrucarion sphinctrinellae*. Sin embargo, tanto su presencia (P

= II) como su tensión ($\Psi = 0.33$) son bastante bajos en todas las asociaciones descritas de esta alianza (Roux 1978). Es, por tanto, en esta comunidad donde parece tener su óptimo ($DR = 36.82 \%$).

- *Solenopsora olivacea* var. *olivacea*: Taxon considerado (Clauzade & Roux 1975) como característica de una forma empobrecida meridional y heminitrófila de la asociación *Verrucarietum cazzae*. Posteriormente, Roux (1978) considera que este taxon tiene su óptimo en la asociación *Caloplacetum subochraceae*, con una presencia de IV y $DR = 5.02 \%$.

En nuestra opinión su óptimo debe encontrarse fuera de ambas asociaciones. Como indica Clauzade & Roux (1975), *Solenopsora olivacea* var. *olivacea* es un taxon heminitrófilo que se instala en biotopos donde se acumulan nitratos y otras sustancias debido a la escorrentía que se produce después de las lluvias. Es, por tanto, en este tipo de hábitats donde encuentra su óptimo, tal y como queda reflejado en nuestros inventarios ($P = V$; $DR = 32.09 \%$).

Al estar en contacto con las asociaciones *Caloplacetum subochraceae* y *Verrucarietum cazzae*, puede presentar formas de transición hacia ellas.

- *Placynthium nigrum*: Taxon de gran amplitud ecológica y que debe ser considerado como diferencial local de la comunidad ($DR = 3.73 \%$).

En conjunto, el grupo de características de la comunidad se encuentra muy bien representado ($RMG = 43.15 \%$) y bien adaptado ($\Psi = 4.33$).

b. *Características de unidades superiores*: La única característica de la alianza *Verrucarion sphinctrinellae* representada en los distintos inventarios realizados es *Verrucaria parmigerella* que, aunque escasamente representada ($P = II$), posee una elevada tensión ($\Psi = 1.56$) debido al alto índice que posee en el inventario 8 lo que enmascara el verdadero papel de esta especie.

Las especies que componen del orden provisional *Verrucarietalia parmigerae* están parcialmente adaptadas ($DR = 7.67 \%$ y $\Psi = 0.67$). Ello es debido a la fuerte dominancia de las características de la comunidad. Tan solo poseen cierta importancia *Verrucaria baldensis* y *Porina linearis*. Es de destacar la desaparición total de *Verrucaria calciseda* (= *V. parmigera*) y *Aspicilia coronata*.

Los táxones característicos de la clase provisional *Protoblastenietea immersae* son muy poco abundantes y están mal adaptados ($DR = 1.17 \%$; $\Psi = 0.21$).

Tab. 6 - Comunidad de *Solenopsora cesatii* y *S. olivacea*.
Solenopsora cesatii and *S. olivacea* community.

Nº de orden	1	2	3	4	5	6	7	8			
Altitud (m)	300	330	250	300	380	80	140	150			
Superficie (dm ²)	100	100	100	200	100	100	50	50			
Orientación	NW	NE	N	NE	N	N	NE	N			
Inclinación (°)	90	90	80	70	70	60	80	90			
Recubrimiento (%)	95	90	85	80	80	90	90	80			
Nº de especies	20	18	11	10	16	19	16	13			
Características de la comunidad											
<i>Solenopsora cesatii</i>	3.3	3.3	3.3	2.2	2.2	2.2	2.2	1.1	V	21.87	36.82
<i>Solenopsora olivacea</i> v. <i>olivacea</i>	2.2	3.3	2.2	3.3	2.2	2.2	2.2	1.1	V	19.06	32.09
<i>Placynthium nigrum</i>	1.1	2.2	+	+	+				IV	2.22	3.73
Características de la alianza											
<i>Verrucaria sphinctrinellae</i>											
<i>Verrucaria parmigerella</i>	+	1.1						2.2	II	2.20	3.70
Características del orden											
<i>Verrucarietalia parmigeriae</i>											
<i>Porina linearis</i>	1.1	1.1	+	+	1.1	1.1	+	1.1	V	1.60	2.69
<i>Verrucaria baldensis</i>	1.1	+	1.1		+			3.3	IV	5.33	8.97
<i>Catillaria lenticularis</i>	+	+			+	+			III	0.55	0.08
<i>Caloplaca aloiciza</i>	+	+			1.1			1.1	III	0.65	1.09
<i>Caloplaca ochracea</i>	+				+			+	II	0.04	0.07
Características de la clase											
<i>Protoblastenietea immersae</i>											
<i>Clauzadea immersa</i>	+	1.1	+		1.1		+	+	IV	0.68	1.15
<i>Protoblastenia rupestris</i>							+		I	0.01	0.02
Transgresivas de la asociación											
<i>Dirinetum repandae</i>											
<i>Dirina massiliensis</i> f. <i>sorediata</i>							+	+	II	0.02	0.03
Transgresivas de la asociación											
<i>Caloplacetum subochraceae</i>											
<i>Caloplaca subochracea</i> v. <i>luteococcinea</i>			+				+		II	0.02	0.03
Transgresivas de la alianza											
<i>Aspicilion calcareae</i>											
<i>Aspicilia calcarea</i>			1.1	+		+	1.1	+	IV	0.66	1.11
<i>Buellia epipolia</i> v. <i>epipolia</i>						+	+	+	III	0.03	0.03
<i>Aspicilia contorta</i>				+		1.1			II	0.32	0.54
Transgresivas de la clase											
<i>Verrucarietalia nigrescentis</i>											
<i>Verrucaria nigrescens</i>	+	+	+		+	+	+	+	V	0.09	0.15
<i>Verrucaria calciseda</i>	1.1	+			1.1		1.1	+	IV	0.96	1.61
<i>Caloplaca variabilis</i> f. <i>paepalostoma</i>			+			+	+		II	0.04	0.07
Transgresivas de la clase											
<i>Collematetea cristati</i>											
<i>Synalissa symphorea</i>	+			+	+	+			III	0.05	0.08
<i>Collema cristatum</i>	+	1.1			2.2				II	2.20	3.70
<i>Psora lurida</i>					+				I	0.01	0.02
Acompañantes											
<i>Xanthoria calcicola</i>	+			+	+	+	+	+	V	1.00	1.63
<i>Caloplaca aurantia</i>		1.1			2.2	+	+		III	0.05	0.08
<i>Squamaria gypsacea</i>	+				+				II	0.04	0.07
<i>Lecanora albescentis</i>		1.2	+	1.2	1.1		+		II	0.02	0.03
<i>Lepraria nivalis</i>	+		+	+		+			II	0.02	0.03
<i>Caloplaca xantholyta</i>	+	+			+				II	0.02	0.03
<i>Squamaria cartilaginea</i>	+	+							II	0.02	0.03
<i>Hymenelia similis</i>	+	+					+		II	0.02	0.03
<i>Caloplaca tenuatula</i> v. <i>lithophila</i>									I	0.01	0.02
<i>Catillaria chalybeia</i>		+		+					I	0.01	0.02
<i>Rinodina controversa</i>							+		I	0.01	0.02
<i>Verrucaria ionaspicarpa</i>						+			I	0.01	0.02
<i>Lecania nylanderiana</i>						+			I	0.01	0.02
<i>Buellia</i> sp.						+			I	0.01	0.02
<i>Caloplaca flavescens</i>							+		I	0.01	0.02

Tab. 7 - Parámetros sintéticos de la comunidad de *Solenopsora cesatii* y *S. olivacea* v. *olivacea*. Número de inventarios: 8; número total de especies: 37; número medio de especies por inventario: 15.37; RMG del conjunto de especies inventariadas: 59.37 %.

Synthetic data of the Solenopsora cesatii and S. olivacea v. olivacea community. Number of releves: 8; total number of species: 37; mean number of species in the releves: 15.37; total mean cover of the species: 59.37 %.

	RMG%	DR %	Q	DQ %	Ψ	
Características de:						
Comunidad	43.15	72.65	2.62	16.77	4.33	Gr. esp. bien adapt.
Al. Verrucaria sphinctrinellae	2.20	3.70	0.37	2.37	1.56	Gr. esp. bien adapt.
Ord. Verrucarietalia parmigerarum	7.67	12.91	3.00	19.20	0.67	Gr. esp. mal adapt.
Cl. Protoblastenietea immersarum	0.69	1.17	0.87	5.57	0.21	Gr. esp. mal adapt.
Transgresivas:						
As. Dirinetum repandae	0.02	0.03	0.25	1.60	0.02	Gr. esp. mal adapt.
As. Caloplacetum subochracearum	0.02	0.03	0.25	1.60	0.02	Gr. esp. mal adapt.
Al. Aspicilion calcarearum	1.01	1.71	1.37	8.77	0.19	Gr. esp. mal adapt.
Cl. Verrucarietalia nigrescentis	1.09	1.83	1.87	11.97	0.15	Gr. esp. mal adapt.
Cl. Collematetalia cristati	2.26	3.80	1.00	6.40	0.59	Gr. esp. mal adapt.
Acompañantes	1.26	2.12	4.12	26.37	0.08	Gr. esp. mal adapt.

c. *Transgresivas*: Predominan las especies que proceden de la clase *Collematetalia cristati* (DR = 3.80%; $\Psi = 0.59$). El resto de especies transgresivas son muy poco abundantes y están mal adaptadas, con índices de tensión inferiores a 0.20.

Alianza *Rinodinium immersarum* Roux 1978

Incluida dentro del orden provisional *Verrucarietalia parmigerarum*. Agrupa a las comunidades que se desarrollan sobre rocas calizas, generalmente duras y compactas. Colonizan paredes más o menos inclinadas (*Verrucarium marmorarum* (Kaiser) Roux 1978) hasta verticales o subverticales (*Caloplacetum tenuatarum* Roux 1978). Se encuentran, en general, orientadas al S, E, NE y NW, expuestas a las precipitaciones directas y al viento, por lo que sufren fuertes variaciones microclimáticas. Se la puede considerar como ombrófila, fotófila y más o menos heliófila.

La alianza tiene su óptimo en el dominio de los encinares y robledales (*Quercus ilex* y *Quercus pubescens*, respectivamente), por lo que se encuentra de forma fragmentaria en nuestro territorio. Debido a esto no se ha podido reconocer ninguna asociación. No obstante, se han realizado 4 inventarios en la provincia de Alicante, que están claramente relacionados con esta alianza.

Comunidad de *Rinodina immersa*

Ecología: Se desarrolla sobre grandes bloques calcáreos duros próximos a la superficie del suelo, en posiciones muy inclinadas o verticales, expuestas a los rayos solares directos.

Distribución: La comunidad sólo se ha detectado, en la Sierra del Montgó y Sierra Helada (Alicante), en el dominio climático de la asociación *Rubio-Quercetum rotundifoliae* y *Quercus-Pistacietum lentisci*, respectivamente.

Fisionomía: Dominan la comunidad los táxones de talo endolítico, que penetran en la roca y forman un tapiz de colores pardo y gris blanquecino, más o menos uniforme, sólo alterado por los hipotalos que separan las distintas especies y los ascomas.

Composición florística (Tabla 8):

Las especies características de la comunidad son: *Rinodina immersa*, *Caloplaca alociza* y *Verrucaria calciseda*. El orden provisional *Verrucarietalia parmigerarum* posee índices de presencia y abundancia-dominancia altos. La clase provisional *Protoblastenietea immersarum* está representada por *Clauzadea immersa*, *C. monticola* y *C. metzleri*.

Como transgresivas, aparecen líquenes con cianofíceas que proceden de la alianza *Collemion rupestris*.

Tab. 8 - Comunidad de *Rinodina immersa*.
Rinodina immersa community.

Nº de orden	1	2	3	4	
Altitud (m)	40	500	30	250	
Superficie (dm ²)	200	30	150	50	
Orientación	N	SW	N	W	
Inclinación (°)	85	70	60	80	
Recubrimiento (%)	100	90	100	90	
Nº de especies	11	14	12	13	
Características de la comunidad					
Rinodina immersa	3.3	3.3	2.2	2.2	V
Características del orden					
Verrucarietalia parmigeriae					
Verrucaria calciseda	2.2	1.1	3.3	1.1	V
Aspicilia coronata	2.2	+	+	1.1	V
Caloplaca alociza	1.1	+	+	+	V
Verrucaria baldensis		1.1		+	III
Características de la clase					
Protoblastenieta immersae					
Clauzadea immersa	+	+	+	+	V
Clauzadea metzleri		1.1		+	III
Clauzadea monticola		+		1.1	III
Transgresivas de la alianza					
Collembion rupestris					
Synalissa symphorea	+	+	+	+	V
Collembion cristatum		+	+		III
Acompañantes					
Caloplaca aurantia	+	1.1	1.1	+	V
Buellia epipolia v. epipolia	+		+		IV
Caloplaca agardhiana	1.1	1.1		1.1	IV
Opegrapha calcarea	+	+	+		IV
Lecanora albescens		+		+	III
Squammarina cartilaginea	+		+		III
Verrucaria nigrescens		+			II

Clase Verrucarietea nigrescentis Wirth 1980

La clase *Verrucarietea nigrescentis* fue descrita por Wirth (1980) para englobar las comunidades líquénicas saxícolas y calcícolas más o menos nitrófilas, de lugares expuestos a la acción de las lluvias, pero que quedan pronto secas tras el cese de las mismas. Se encuentra bien representada en la Región Mediterránea Occidental: SE de Francia (Roux 1978), Madrid (Merino 1981), Granada (Casares 1984, Casares & Llimona 1986), Alicante (Alonso 1987), Sur de Cataluña (Boqueras *et al.* 1988) y Murcia (Baeza 1989). Casares (1984) considera especies características de esta clase: *Caloplaca variabilis*, *C. velana*, *Candelariella aurella*, *Lecanora dispersa* y *Verrucaria nigrescens*, las cuales son bastante frecuentes en el litoral de nuestro área de estudio.

Orden Verrucarietalia Klement 1950

Este sintaxon, de acuerdo con Casares &

Llimona (1986), está insuficientemente definido y presenta características muy heterogéneas. Muchas de las especies incluidas en el orden por diversos autores (Hadač 1944, Klement 1950, 1955), se han utilizado posteriormente para definir a distintas unidades sintaxonómicas. De momento, y hasta que futuras investigaciones permitan solucionar este problema, consideramos como características del orden las mismas especies que definen a la clase.

Wirth (1980) incluye dentro del orden las alianzas: *Caloplacion decipiens* y *Aspicilion calcareae*. A juzgar por las especies características señaladas por diversos autores (Klement 1950, Clauzade & Roux 1975, Roux 1978, Casares 1984, Casares & Llimona 1986), ambas alianzas deben de estar presentes en nuestra zona de estudio. Sin embargo, tan solo hemos reconocido una comunidad que incluimos en la segunda de las alianzas mencionadas.

Alianza Aspicilion calcareae Albertson 1946 ex Roux 1978

Está constituida por comunidades líquénicas saxícolas, basófilas, de poco a medianamente nitrófilas, ombrófilas y más o menos heliófilas. En general están poco protegidas o incluso se encuentran expuestas a los vientos dominantes, por lo que, después de las lluvias se secan más o menos rápidamente. Colonizan las superficies horizontales o poco inclinadas, situadas a ras de suelo o elevadas un poco por encima de éste, las pequeñas piedras esparcidas por el suelo y la parte superior de los bloques rocosos, donde se acumulan las deyecciones de las aves.

Son características de esta alianza (Roux 1978, Casares 1984, Casares & Llimona 1986): *Aspicilia calcarea*, *A. contorta*, *A. cheresina*, *A. radiosa*, *Buellia epipolia*, *Caloplaca tenuatula* ssp. *inconnexa*, *Opegrapha rupestris*, etc.

Comunidad de Aspicilia calcarea y Xanthoria calcicola

Bajo este nombre se han reunido un grupo de inventarios dominados por especies nitrófilas de amplia distribución, como son: *Xanthoria calcicola*, *Caloplaca aurantia*, *C. flavescens* y *Aspicilia calcarea*. En nuestra opinión reúne dos comunidades que se diferencian por su ecología, pero que por su composición florística son muy difíciles de separar. *Xanthoria calcicola* y *Caloplaca aurantia*, están presentes en todos los inventarios. *Caloplaca flavescens* está representada en los inventarios 1 al 14 y *Aspicilia calcarea* en

los inventarios 18 al 28.

Ecología: Los inventarios 1 al 17, colonizan las crestas o aristas de bloques rocosos muy iluminados y soleados, donde se acumulan las deyecciones de las aves. Los inventarios del 18 al 28 se han realizado en lugares soleados y más o menos nitrificados, sobre los grandes bloques calizos más o menos horizontales y próximos a la superficie del suelo, por lo que retienen la humedad de las lluvias un cierto tiempo. En ambos casos, reciben las precipitaciones directas y están sometidas a la acción de los vientos dominantes por lo que sufren importantes variaciones térmicas e higrométricas. El tipo de substrato sobre el que se acomoda es, principalmente, roca calcárea dura o compacta.

Por el momento y hasta que no se realice un tratamiento más profundo, no es posible diferenciar dos unidades sintaxonómicas.

Distribución: Ampliamente extendida por todo el litoral mediterráneo peninsular, siempre en zonas nitrificadas. Constituye, sin duda, la vicariante de la asociación *Dermatocarpetum monstrosi* Klement 1955, localizada sobre rocas calizas, en el sur y sureste de España por encima de los 600 m sm, así como de la asociación *Ramalinetum bourgeanae* Llimona & Egea 1984, frecuente sobre las rocas ácidas del litoral del sureste de España. Por su amplia distribución, se asienta sobre diversos tipos de vegetación potencial.

Fisionomía: La comunidad está dominada por los talos crustáceos, placodiomorfos, de colores vivos: amarillo-anaranjado o rojo-anaranjado de *Xanthoria calcicola*, *Caloplaca aurantia* y frecuentemente también *C. flavescens*. Entre ellos (y sobre todo en los inventarios del 18 al 28) se desarrollan grandes manchas de color blanquecino de *Aspicilia calcarea* y, en ocasiones, *Verrucaria calciseda*, lo que determina que los tonos dominantes en la comunidad sean el blanco.

Composición florística (Tablas 9 y 10):

a. **Características de la comunidad:** Hemos considerado como características de la comunidad tres especies altamente nitrófilas: *Xanthoria calcicola*, *Caloplaca aurantia* y *C. flavescens*. Forman un grupo muy bien adaptado (DR = 51.16 %, Ψ = 2.89).

Xanthoria calcicola es la especie dominante, presenta los índices de presencia y abundancia-dominancia más elevados, lo que determina un DR = 33.06 %.

Caloplaca aurantia, considerada como característica de la alianza *Caloplacion decipiens*,

presenta también índices elevados, con DR = 16.71 %.

Caloplaca flavescens es la peor representada de las tres, con un índice de abundancia-dominancia muy bajo y DR = 1.39 %.

b. **Características de unidades superiores:** La alianza *Aspicilion calcareae*, definida con anterioridad, está bien representada en nuestros inventarios aunque destaca notablemente *Aspicilia calcarea*, tanto por su presencia como por los valores de los índices que alcanza (DR = 28.74 %), sobre todo en los últimos inventarios de la tabla (del 18 al 28). En conjunto, representan un grupo de especies muy bien adaptado (DR = 29.73 %, Ψ = 1.93).

La presencia bastante frecuente en los inventarios de *Verrucaria nigrescens*, *V. calciseda*, *Caloplaca variabilis* y *Lecanora dispersa*, permite encuadrarla en la clase *Verrucarietea nigrescentis*. Ahora bien, las características de la clase, constituyen un grupo de especies mal adaptado (DR = 9.65 %, Ψ = 0.48).

c. **Transgresivas:** Todas inadaptadas y limitadas a áreas poco nitrificadas. Proceden de unidades ombróforas (*Dirinetum repandae*: DR = 0.38 %, Ψ = 0.38), ombrófilas (*Caloplacetum subochraceae*: DR = 0.26 %, Ψ = 0.08), *Verrucarion sphinctrinellae*: DR = 0.22 %, Ψ = 0.15, *Protoblastenietea immersae*: DR = 0.8 %, Ψ = 0.23) o higrófilas (*Collematetea cristati*: DR = 0.03 %, Ψ = 0.02).

Clase provisional Roccelletea phycopsis Egea 1989

Agrupar a comunidades saxícolas constituidas por líquenes crustáceos y fruticulosos que tienen, en gran parte, *Trentepohlia* como fotobionte. Su óptimo ecológico lo encuentran en hábitats que están protegidos del impacto directo de las gotas de lluvia, o en lugares algo expuestos a ella, pero en los que el substrato se seca rápidamente. Se localiza en zonas térmicas y umbrías litorales o sublitorales. Se instalan en paredes verticales o superverticales y en oquedades, techos y pequeñas cuevas, poco o nada soleadas, orientadas entre el noroeste y noreste. De acuerdo con Egea (1989), la clase se puede caracterizar como: saxícola, termófila, xerorresistente, aerohigrófila, ombrófora, halotolerante, algo o poco fotófila, heliófora y poco o nada nitrófila.

Especies características, que aparecen en nuestros inventarios, son: *Dirina massiliensis* f. *sorediata*, *Rocella phycopsis* y *Thelopsis isiaca*.

Tab. 9 - Comunidad de *Aspicilia calcarea* y *Xanthoria calcicola*.
Aspicilia calcarea and *Xanthoria calcicola* community.

Nº de orden	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Altitud (m)	180	300	50	50	170	350	50	150	40	100	450	150	150	360	550	150	170	170	180	450	550
Superficie (dm ²)	30	60	50	200	50	70	60	200	150	50	60	100	50	15	50	30	30	50	200	150	150
Orientación	E	NE	NE	W	SE	N	E	N	E	E	N	N	NE	NE	E	NE	SE	N	W	NE	SE
Inclinación (°)	60	70	25	80	70	10	20	30	50	45	60	20	20	5	70	20	10	5	25	15	45
Recubrimiento (%)	85	90	85	80	85	80	60	50	90	70	100	100	100	95	60	90	90	90	100	60	
Nº de especies	12	24	11	8	16	15	12	16	10	10	18	18	10	23	19	11	12	9	10	14	18
Características de la comunidad																					
Xanthoria calcicola	5.4	3.4	3.3	3.3	3.3	3.3	2.2	2.2	1.1	2.2	2.2	2.2	2.2	2.3	1.1	3.3	2.2	1.1	1.2	1.1	+
Caloplaca aurantia	+	2.2	2.2	2.2	1.1	+	1.1	+	2.2	1.2	1.1	2.2	1.1	1.1	3.3	1.1	3.3	2.2	1.1	1.1	1.1
Caloplaca flavescens	+	+	+	+	+	+	2.2	+	1.1	+	+	+	+	+	+						
Características de la alianza																					
Aspicilion calcareae																					
Aspicilia calcarea	1.1	1.1			1.1	1.1			3.3		1.1			3.3	+			3.3	3.3	3.3	3.3
Buellia epipolia v. epipolia	+	+	+			+		+			+	+	+	+	+			+			+
Aspicilia cheresina					+	+					+			+	+			+	+		
Toninia episema		+			+	+					+			+				+			
Opegrapha rupestris							+												+		
Caloplaca tenuatula ssp. inconnexa		+				+															
Características de la clase																					
Verrucarietia nigrescentis y orden																					
Verrucarietalia parmigeriae																					
Verrucaria nigrescens	+	1.1	+	+	+	+	+	+	1.1	+	+	+	+	+	+	1.1	+	1.1	1.1	1.1	+
Verrucaria calcisida		2.2	1.1	+		1.1	1.1		+		1.1		+	1.1	1.1						1.1
Caloplaca variabilis f. chalybea	+	+		+	+			+			+			+			+	+	+	+	+
Lecanora dispessa					+			+	+			+				1.1	+	+	+	+	+
Caloplaca variabilis f. paepalostoma					+							+									
Caloplaca variabilis f. variabilis												+									
Candelariella aurella												+									
Transgresivas de la asociación																					
Dirinetum repandae																					
Dirina massiliensis f. massiliensis																	+	1.1			
Dirina massiliensis f. sorediata								1.1									+				
Transgresivas de la asociación																					
Caloplacetum subochraceae																					
Caloplaca subochracea v. luteococcinea					+			1.1				+					+				
Caloplaca subochracea v. subochracea		+														+					
Lecanora agardhiana					+							+		+							+
Topelia heterospora																					
Petractis luetkemulleri																					
Solenopsora olivacea																					
Transgresivas de la alianza																					
Verrucarion sphinctrinellae																					
Verrucaria parmigerella					+				+												
Opegrapha calcarea							+		+												
Transgresivas del orden																					
Verrucarietalia parmigeriae																					
Caloplaca alociza	+	+	+		+	+			1.1	+		+	+	+	+	+	1.1	+	+	+	1.1
Verrucaria baldensis	+	+			+	+			+	+		+	+	+	1.1	+	+	+	1.1	+	+
Aspicilia coronata	+	+							+			+	+	+	+	2.2	+			2.2	1.1
Catillaria lenticularis	+	+			+				+	1.1	+			+	+						+
Caloplaca ochracea		+												1.1	+						
Porina linearis																					+
Staurothele immersa		+																			
Transgresivas de la clase																					
Protoblastenietea immersae																					
Clauzadea immersa		+	+				+		1.1					1.1	1.1	+				+	+
Clauzadea monticola														+	+					+	1.1
Transgresivas de la clase																					
Collematetea cristati																					
Synalissa symphorea		+						+				+		+	+						
Collema cristatum																					
Acompañantes																					
Lecanora albescens		+				+		+			+	+		+							+
Caloplaca agardhiana	+	+	+							1.1		+	+	+							+
Verrucaria lecidoides		+						+				+	+	+	+					1.1	+
Rinodina immersa				+		+									+						+
Caloplaca tenuatula v. athallina											+						+			+	+
Caloplaca tenuatula v. lithophila																					+
Caloplaca velana v. schaeferi		+		+					+												+
Toninia aromatica				+				+	+												
Verrucaria muralis								+	+												
Candelariella oleaginascens									+												
Lecania turicensis					+																
Rinodina bischoffii							+														
Diploicia subcanescens									+												
Verrucaria glauca																					
Squamaria cartilaginea														1.1							
Solenopsora candicans														+							
Lecanora muralis																		+			
Buellia sequax																					

[illegible]

● **Orden provisional** *Dirinetaia massiliensis* Egea
1989

Tiene su óptimo en las rocas calizas de la Región Mediterránea. Llega de forma puntual a las Islas Británicas y, probablemente, al sur de los Países Escandinavos. No se conoce de la Región Macaronésica, debido a la ausencia de sustrato favorable para su desarrollo.

Especies características de esta unidad son: *Dirina massiliensis*, *Opegrapha mougeotii*, *O. variaeformis*, *O. calcarea* (dif.) y *Caloplaca velana* var. *schaereri* (dif.)

Alianza Roccellion phycopsis Egea & Llimona
1984

En un principio, la alianza fue propuesta (Egea & Llimona 1984) para agrupar las comunidades saxícolas de rocas ácidas y básicas de la Región Mediterránea, en la que se citaban como características *Roccella phycopsis* y *Thelopsis isiaca*. Egea (1989), la restringe a comunidades de rocas calizas y los dos táxones citados los sitúa entre las características de la clase. *Lecanographa grumulosa* es la especie mejor representada en la alianza, ya que posee una presencia y un recubrimiento medio global bastante elevado en todas las comunidades calcícolas de la Región Mediterránea.

Asociación *Dirinetum repandae* (Clauzade & Roux 1975) em. Roux 1978

Ecología, Distribución y Fisionomía: Véase Clauzade & Roux 1975 y Egea 1989.

Composición florística (Tablas 11 y 12):

a. *Características de la asociación y de la alianza*: De las especies señaladas por Egea (1989) como características de ambos sintáxones, en nuestros inventarios, se encuentran representados *Dirina immersa* y *Lecanographa grumulosa*.

Dirina immersa, con DR = 15.49 %, es un taxon que puede pasar fácilmente desapercibido por su parecido con los talos estériles y los picnidios de *Dirina massiliensis*. Tiene su óptimo en zonas áridas o semiáridas de la Región Mediterránea.

Lecanographa grumulosa .con índices de P = V y DR = 9.75 %, determina una variante esciáfila de *Dirinetum repandae* subas. *roccelletosum phycopsis* Clauzade & Roux 1975.

Como característica de la asociación incluimos también a *Ingaderia troglodytica*, especie conocida del norte de Marruecos, sureste de la Península Ibérica, Baleares y Cerdeña (Feige & Lumsch 1993).

En conjunto, estas tres especies, y sobre todo

Tab. 10 - Parámetros sintéticos de la comunidad de *Aspicilia calcarea* y *Xanthoria calcicola*. Número de inventarios: 10; número total de especies: 55; número medio de especies por inventario: 13.60; RMG del conjunto de especies inventariadas: 48.15 %.

Synthetic data of the Aspicilia calcarea and Xanthoria calcicola community. Number of releves: 10; total number of species: 55; mean number of species in the releves: 13.60; mean total cover of the species: 48.15 %.

	RMG%	DR %	Q	DQ %	Ψ	
Características de:						
Comunidad	26.54	51.16	2.50	17.68	2.89	Gr. esp. bien adapt.
Al. Aspicilion calcareae	14.32	29.73	2.17	15.34	1.93	Gr. esp. bien adapt.
Cl. Verrucarietia nigrescentis y						
Ord. Verrucarietalia	4.65	9.65	2.85	20.15	0.48	Gr. esp. mal adapt.
Transgresivas:						
As. Dirinetum repandae	0.18	0.38	0.14	0.99	0.38	Gr. esp. mal adapt.
As. Caloplacetum subochraceae	0.13	0.26	0.46	3.25	0.08	Gr. esp. mal adapt.
Al. Verrucarion sphinctrinellae	0.11	0.22	0.21	1.48	0.15	Gr. esp. bien adapt.
Ord. Verrucarietalia parmigerae	3.22	6.66	2.46	17.39	0.38	Gr. esp. mal adapt.
Cl. Protoblastenietea immersae	0.39	0.80	0.50	3.53	0.23	Gr. esp. mal adapt.
Cl. Collematetia cristati	0.02	0.03	0.25	1.76	0.02	Gr. esp. mal adapt.
Acompañantes	0.50	1.74	2.60	18.38	0.09	Gr. esp. mal adapt.

las dos primeras, forman un grupo de especies bien adaptadas (DR = 25.41 %, Ψ = 1.51).

b. *Características del orden provisional Dirinetalia massiliensis*: Especies características de esta unidad representadas en nuestros inventarios, son: *Dirina massiliensis* y *Opegrapha mougeotii*, aunque esta última de forma esporádica. Con DR = 32.89 % y Ψ = 2.86, valores debidos exclusivamente a *Dirina massiliensis*, constituyen un grupo de especies muy bien adaptado.

c. *Características de la clase provisional Roccelletea phycopsis*: Este sintaxon está bien representado y adaptado (DR = 40.41 %, Ψ = 1.30), sobre todo debido a los altos índices de *Dirina massiliensis* f. *sorediata* y, en algunos casos, *Rocella phycopsis*.

d. *Transgresivas*: Todas inadaptadas. Proceden de unidades con sustrato más poroso (*Opegraphetum durieui*: DR = 0.03 % y Ψ = 0.01), unidades que ocupan zonas más iluminadas y menos protegidas del agua de lluvia (*Caloplacetum subochraceae*: DR = 0.39 % y Ψ = 0.06, *Verrucarietalia parmigerae*: DR = 0.06 % y Ψ = 0.01) o de unidades más nitrófilas (*Aspicilion calcareae*: DR = 0.01 % y Ψ = 0.007, *Verrucarietia nigrescentis* y *Verrucarietalia*: DR = 0.04 % y Ψ = 0.01).

Asociación *Opegraphetum durieui* Egea & Roux 1992

Comunidad limitada al litoral de la Región Mediterránea sobre calizas porosas o calizas-arenosas. Los inventarios de que se dispone han sido utilizados en el cuadro descriptivo de la asociación (Roux & Egea 1992).

Otras comunidades estudiadas

Comunidad de *Xanthoria resendei*

Ecología: Presenta la misma ecología que la asociación *Xanthorietum resendei* Llimona 1975 descrita de rocas ácidas (Llimona 1975, Egea & Llimona 1982, 1987). Su óptimo se encuentra en superficies de rocas calizas muy iluminadas y soleadas, poco inclinadas, sometidas a un importante aporte de nitratos (excrementos de aves). Está sometida a la influencia más o menos grande de los vientos dominantes, en zonas muy próximas al litoral, con ombroclima semiárido.

Distribución: Roux (1991) señala para esta comunidad un área mucho más reducida que para la asociación *Xanthorietum resendei* de rocas ácidas. Hasta la fecha se conoce de: SW de Portugal, S de España, Cataluña y SE de Francia. En nuestra zona de estudio se ha detectado su

Tab. 11 - Asociación *Dirinetum repandae*.
Dirinetum repandae association.

Nº de orden	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26			
Altitud (m)	150	10	300	50	200	300	50	50	150	50	120	30	100	170	10	350	350	150	10	30	170	180	60	70	160	50			
Superficie (dm²)	200	100	100	100	100	150	100	150	100	100	150	100	50	100	50	200	200	100	30	20	100	100	70	80	50	100			
Orientación	NE	N	NE	NE	NE	NE	N	NE	N	N	N	N	NE	N	N	N	NE	NE	N	N	N	N	NE	NE	NE	N			
Inclinación (º)	80	90	90	80	80	90	95	90	120	85	90	90	90	100	95	100	90	120	100	110	100	100	110	110	90	90			
Recubrimiento (%)	100	90	95	100	100	95	100	100	90	95	100	100	95	85	90	90	100	95	100	90	85	70	100	100	100	80			
Nº de especies	14	11	7	6	13	14	9	11	8	15	8	10	9	8	6	5	5	5	6	9	7	5	9	11	4	9			
Características de la asociación y alianza																													
Dirina immersa	4.4	3.4	3.3	3.3	2.2	2.2	2.2	2.1	1.1	1.1	1.2	1.2	1.1	+													III	9.52	15.49
Lecanactis grumulosa	+	2.2	(+)	1.1			1.1	+	2.1		2.2	2.2	+	+	1.1	2.2	2.2	2.2	1.1	+	+	+	1.1	3.3			V	5.99	9.75
Ingaderia troglodytica		1.1										+												+			I	0.10	0.16
Características del orden Dirinetalia massiliensis																													
Dirina massiliensis	+	1.1	1.1				+	1.1	1.1	+	3.2	+	2.3	3.3	2.2	3.3	4.4	4.3	3.3	3.3	3.3	3.3	2.2	3.3	1.1	1.2	V	20.20	3.29
Opegrapha mougeotii												+															I	0.01	0.01
Características de la clase Roccelletea phycopsis																													
Rocella massiliensis f. sorediata	+	+	1.1	1.1	2.2	1.1	2.2	3.3	2.1	3.3	3.3		2.2	3.3	1.1	3.3	3.3	3.3	2.2	3.3	3.3	3.3	+	+	4.5	3.3	V	21.55	35.08
Rocella phycopsis	1.1	+	+	1.1			1.1	1.2	+		1.1	+	1.1	+	+	+	2.1	2.2	2.2	1.1	(+)	1.1	+	1.1			V	2.63	4.28
Opegrapha calcarea	+	+	+		+		+			+		+		+		1.1					+		1.1	+	1.1		III	0.33	0.53
Thelopsis isiaca	+	1.1		+	1.1	+		+		+	+	+			1.1				+				1.1	+	1.1	+	III	0.31	0.50
Transgresivas de la asociación Opegraphetum durieui																													
Arthonia meridionalis		+										+											+	+			I	0.01	0.02
Opegrapha durieui		+										+															I	0.01	0.01
Transgresivas de la asociación Caloplacetum subochraceae																													
Caloplaca subochracea v. luteococcinea	1.1				+	1.1			+		+							+									II	0.21	0.34
Porina oleriana v. ginzbergeri					+		+	+			+	+															I	0.02	0.03
Caloplaca subochracea v. subochrace																	+										I	0.01	0.01
Topelia heterospora							+																				I	0.01	0.01
Solenopsora olivacea v. olivacea										+																	I	0.01	0.01
Transgresivas del orden Verrucarietalia parmigeriae																													
Porina linearis		+			+	+		+															+	+			II	0.02	0.03
Opegrapha rupestris	+				+	+				+															+		I	0.02	0.03
Transgresivas de la alianza Aspicilia calcareae																													
Buellia epipolia																									+		I	0.01	0.01
Rinodina bischoffii											+																I	0.01	0.01
Aspicilia calcarea										+																	I	0.01	0.01
Transgresivas de la clase Verrucarietalia nigrescentis y orden Verrucarietalia																													
Caloplaca variabilis f. chalybaea					+	+																			+		I	0.01	0.02
Caloplaca variabilis f. paepalostoma	+																								+		I	0.01	0.01
Candelariella aurella										+										+							I	0.01	0.01
Lecanora dispersa	+																										I	0.01	0.01
Acompañantes																													
Caloplaca velana v. schaeferi	+		+	1.1				+		1.1	+		+	+	+				+	+	+	+	+	+	+	+	IV	0.25	0.01
Xanthoria calcicola	+						+	+		+										+							II	0.02	0.03
Lecania turicensis										+				+								+					I	0.01	0.02
Caloplaca flavescens					+	+				+																	I	0.01	0.02
Caloplaca aurantia					+	+			+																		I	0.01	0.02
Verrucaria muralis					+	1.1				+																	I	0.01	0.01
Buellia sequax						+							+							+							I	0.01	0.02
Lecanora albescens														+		+					+				+		I	0.01	0.02
Petractis thelotremella								+															+	+			I	0.01	0.02

Tab. 12 - Parámetros sintéticos del *Dirinetum repandae*. Número de inventarios: 26; número total de especies: 38; número medio de especies por inventario: 8.65; RMG del conjunto de especies inventariadas: 61.41 %.

Synthetic data of the Dirinetum repandae association. Number of relevés: 26; total number of species: 38; mean number of species in the relevés: 8.65; total mean cover of species: 61.41 %.

	RMG%	DR %	Q	DQ %	Ψ	
Características de:						
Asociación y Alianza	15.61	25.41	1.46	16.80	1.15	Gr. esp. bien adapt.
Ord. Dirinetalia massiliensis	20.20	32.89	1.00	11.50	2.86	Gr. esp. bien adapt.
Cl. Roccelletea phycopsis	24.82	40.41	2.69	30.59	1.30	Gr. esp. bien adapt.
Transgresivas:						
As. Opegraphetum durieui	0.02	0.03	0.23	2.66	0.01	Gr. esp. mal adapt.
As. Caloplacetum subochraceae	0.24	0.39	0.53	6.09	0.06	Gr. esp. mal adapt.
Ord. Verrucarietalia parmigeriae	0.04	0.06	0.42	4.83	0.01	Gr. esp. mal adapt.
Al. Aspicilion calcareae	0.01	0.01	0.12	1.38	0.01	Gr. esp. mal adapt.
Cl. Verrucarietalia nigrescentis y						Gr. esp. mal adapt.
Ord. Verrucarietalia	0.03	0.04	0.30	3.45	0.01	Gr. esp. mal adapt.
Acompañantes	0.44	0.73	1.96	22.55	0.03	Gr. esp. mal adapt.

presencia en el Cabo de Cope (Murcia) y en el Puente del Cura (Almería), en los dominios climáticos de las asociaciones *Mayteno-Periplocetum angustifoliae* y *Zizipho-Maytenetum europaei*, respectivamente.

Fisionomía: Es una comunidad muy uniforme, que llama la atención por la variada gama de colores rojizos y anaranjados de los talos de *Xanthoria resendei*, *X. calcicola*, *Caloplaca aurantia* y *C. flavescens*, entre los que pueden verse manchas blanquecinas de *Aspicilia calcarea* y *Caloplaca variabilis* f. *chalybaea*. Al igual que sucede sobre rocas ácidas, la cobertura y número de especies es bastante baja a causa de las condiciones extremas en las que se desarrolla.

En la tabla 13 se transcriben los dos inventarios realizados de esta comunidad.

Comunidad de *Caloplaca xantholyta* y *Lepraria nivalis*

Ecología: Coloniza las oquedades y superficies extraplomadas por donde rezuma el agua y donde la humedad atmosférica es relativamente elevada, situadas al abrigo de la lluvia y en condiciones de muy baja iluminación.

Distribución: Se sitúa entre los pisos termo y supramediterráneo. Hasta la fecha, se ha detectado su presencia en el sur de Francia (Clauzade & Roux 1975), en las calizas del centro de España (Merino

1981), en Granada (Casares 1984), Tarragona (Navarro-Rosinés 1992) y Murcia (Baeza 1989). Casares (o. c.) es el único que aporta inventarios (diez) de la comunidad. Nosotros la hemos localizado en la Sierra del Montgó, en Denia

Tab. 13 - Comunidad de *Xanthoria resendei*.
Xanthoria resendei community.

Nº de orden	1	2
Altitud (m)	40	100
Superficie (dm ²)	60	200
Orientación	N	E
Inclinación (°)	40	60
Recubrimiento (%)	80	60
Nº de especies	16	16
<i>Xanthoria resendei</i>	3.3	3.2
<i>Xanthoria calcicola</i>	2.2	2.3
<i>Aspicilia calcarea</i>	1.1	1.1
<i>Caloplaca aurantia</i>	1.1	1.1
<i>Caloplaca variabilis</i> f. <i>chalybaea</i>	+	1.1
<i>Caloplaca flavescens</i>	+	+
<i>Caloplaca velana</i> v. <i>velana</i>	+	+
<i>Lecania turicensis</i>	+	+
<i>Toninia aromatica</i>	+	+
<i>Verrucaria nigrescens</i>	+	+
<i>Verrucaria</i> sp.	+	+
<i>Buellia epipolia</i> v. <i>epipolia</i>	+	+
<i>Buellia sequax</i>	+	+
<i>Lecanora albescent</i>	+	+
<i>Caloplaca tenuatula</i> v. <i>lithophila</i>	+	
<i>Verrucaria muralis</i>	+	
<i>Lecanora dispersa</i>		+
<i>Dirina massiliensis</i> f. <i>sorediata</i>		+

(Alicante), en el dominio climático del *Rubio-Quercetum rotundifoliae* y en la Sierra de Cabrera, en Turre (Almería), en el dominio climático del *Ziziphetum loti*.

Fisionomía: La comunidad presenta como biotipo dominante el lepraroide, debido a la elevada presencia de *Caloplaca xantholyta*, *Lepraria nivalis* y *L. incana*. Los tres táxones forman manchas más o menos alargadas de color amarillo, blanco y blanco-grisáceo, respectivamente. Entre estas manchas destacan, en ocasiones, otras de color negro que corresponden a *Collema crispum*.

Composición florística: El grupo de especies consideradas como características es el único que está ampliamente representado y, por tanto, muy bien adaptado.

A continuación se transcribe un inventario de esta comunidad tomado en la Sierra del Montgó (Denia), en un entrante o pequeña cueva, en la parte inferior de un gran bloque calizo a 20 cm del suelo, a una altitud de 310 m, sobre un área de 15 dm², en una superficie extraplomada de 120° de inclinación, con una orientación NE y con un recubrimiento de especies del 80 %: *Lepraria nivalis* (2.2), *Lepraria incana* (2.2), *Caloplaca xantholyta* (2.2), *Collema crispum* (1.1), *Opegrapha calcarea* (+), *Solenopsora cesatii* (+), *Verrucaria calciseda* (+).

Comunidad de *Heppia solorinoides* y *Psora vallesiaca*

Ecología: Se trata de una comunidad estrictamente terrícola, que cubre grandes extensiones entre los claros que deja la vegetación superior. Predomina en las exposiciones soleadas, en suelos compactos, duros, secos y muy poco inclinados. Es por tanto una comunidad heliófila, xerófila, ombrófila, termófila y calcífila.

Distribución: Hasta el momento, la comunidad tiene su óptimo en el SE de la Península Ibérica y en el Algarve portugués, en zonas con ombroclima de semiárido a seco. Por su amplitud geográfica, se instala en el área de diversos dominios climáticos.

Fisionomía: El aspecto de la comunidad está dominado por los tonos blancos de *Diploschistes diacapsis* (RMG = 10.41 %) y *Heppia solorinoides* (RMG = 7.35 %), los pardos más o menos oscuros de *Psora vallesiaca* (RMG = 3.08 %) y *Catapyrenium squamulosum* (RMG = 7.15 %) y el amarillo de *Fulgensia subbracteata*, *F. fulgida* y *F. fulgens* (RMG = 4.13 %).

Los líquenes de tonalidad verdosa más o menos clara, en conjunto, pueden ser abundantes en la comunidad y suelen ser llamativos en los periodos de lluvia ya que en épocas secas están cubiertos de una gruesa capa de polvo y pruina o, como en el caso de *Cladonia foliacea*, muestran la superficie inferior blanquecina de las escuámulas.

Composición florística (Tablas 14 y 15): La especial configuración del medio donde se desarrolla esta comunidad, sometida a una elevada exposición al sol, viento y lluvia, no permite un gran desarrollo talino a las especies que forman la asociación, que aunque no son escasas (11 por término medio), raramente llegan a tener índices de abundancia-dominancia elevados.

a. **Características de la comunidad:** Se han considerado como características los táxones siguientes: *Heppia solorinoides*, *Psora vallesiaca* y *Toninia tristis* ssp. *pseudotabacina*. Constituyen un grupo bien adaptado (DR = 28.12% y Ψ = 1.44), debido, sobre todo, a la primera de las especies citadas.

b. **Características de unidades superiores:** La alianza *Psorion saviczii* es una unidad medianamente adaptada (DR = 39.71%, Ψ = 0.80). *Diploschistes diacapsis* es la única especie que, en nuestro área de estudio, se ha detectado como característica del orden *Fulgensietalia desertori*. La clase, aunque es la unidad que mayor número de especies presenta, constituye un grupo medianamente adaptado al tener coeficientes de DR = 39.71% y Ψ = 0.80.

APENDICE

Tabla 2. *Caloplacetum subochraceae*

Localización de los inventarios: 1. Denia: Sierra del Montgó. BD 4900. Pared vertical de caliza compacta orientada al N, a 1 m del suelo. 2, 3, 4, 5 y 6. Calpe: Peñón de Ifach. BC4580. Superficies fuertemente inclinadas de caliza compacta. 7 y 8. Cartagena: Sierra de la Muela. XG6861. Pared vertical extraplomada con orientación N. 9 y 10. Jávea: Cabo de San Antonio. BC5799. Superficie inclinada de caliza compacta, con orientación NE. 11. Cartagena: Cabo Tiñoso. XG6457. Pared vertical extraplomada de caliza margosa. 12. Cartagena: Cabezo El Cambrón. XG6361. Superficie inclinada de caliza compacta con orientación NE. 13. Como el nº 12 pero en pared vertical extraplomada. 14. Cabo de Palos: Cabezo de la Fuente. XG 9764. Superficie vertical de caliza compacta. 15. Como en nº 12.

Síntesis de las características de los inventarios: Altitud: máxima 300 m, media 160.33, mínima 75 m. Orientación: 53.33 % al N, 40 % al NE, 6.66 % al NW. Inclinación: máxima 120°, media 74.67°, mínima 40°. Recubrimiento: máximo 100%, medio 98%, mínimo 95%.

Tab. 14 - Comunidad de *Heppia solorinoides* y *Psora vallesiaca*.
Heppia solorinoides and *Psora vallesiaca* community.

Nº de orden	1	2	3	4	5	6	7	8	9	10	11	12	13
Altitud (m)	200	250	150	300	150	20	20	30	25	20	300	330	150
Superficie (dm ²)	100	30	100	100	500	100	10	20	10	100	100	30	50
Orientación	E	SE	-	-	-	-	-	W	E	-	N	-	S
Inclinación (°)	30	50	0	0	0	0	0	5	5	10	5	0	10
Recubrimiento (%)	50	70	80	90	60	90	70	80	80	80	50	80	80
Nº de especies	15	11	10	16	11	12	12	9	7	8	9	8	10
Características de la comunidad													
Heppia solorinoides	2.2	2.2	2.2	1.1	+	+	+	2.2	2.2	2.2	1.1	+	+
Psora vallesiaca	2.2	1.1	1.1	2.2	1.1	+	1.1						
Toninia tristis ssp. pseudotabacina	1.1	1.1	+	+	1.1	2.2	+						
Características de la alianza													
Psorion saviczii													
Acarospora nodulosa v. reagens	1.1		+	1.1	+					1.1			
Buellia zoharyi							+	1.2					
Características del orden													
Fulgensietalia desertori													
Diploschistes diacapsis ssp. diacapsis	2.2	1.1	3.3	2.2	2.3	2.2	+	+	2.2	2.2	1.1	+	
Características de la clase													
Psoretea decipientis													
Catapyrenium squamulosum	+	2.2	1.1	1.1	2.2	+	1.1	3.3	2.2	1.1	+	+	+
Psora decipiens	1.1	+	1.1	2.2	+	1.1	1.1	1.1	2.2	1.1	1.1	2.2	+
Fulgensia subbracteata	+	+	+	+	+	+	+	1.1	2.2		+	2.2	1.1
Squamarina cartilaginea	+	+	+	+	1.1	+	+	+	+		+	+	1.1
Squamarina lentigera	+		+	+	1.1	+	1.1			+			
Toninia sedifolia	+			+						+		1.1	
Fulgensia fulgens						+	2.2			+		1.1	
Fulgensia fulgida	+	+		+									
Acompañantes													
Collema crispum	+			1.1	+	1.1	+	1.1					
Toninia aromatica								+	+		+	1.1	
Cladonia pyxidata								+			1.1	+	
Lepraria nivalis				+							+		1.1
Heppia turgida	+	+		+									
Cladonia foliacea v. convoluta	+											+	
Peltula patellata				1.1									
Heppia gigantea		2.2											

Tab. 15 - Parámetros sintéticos de la comunidad de *Heppia solorinoides* y *Psora vallesiaca*. Número de inventarios: 13; número total de especies: 22; número medio de especies por inventario: 10.61; RMG del conjunto de especies inventariadas: 43.3 %.

Synthetic data of the Heppia solorinoides and Psora vallesiaca community. Number of relevés: 13; total number of species: 22; mean number of species in the relevés: 10.61; mean total cover of species: 43.3 %.

	RMG%	DR %	Q	DQ %	Ψ	
Características de:						
Comunidad	12.18	28.12	2.07	19.50	1.44	Gr. esp. bien adapt.
Al. Psorion saviczii	0.79	1.82	0.54	5.09	0.36	Gr. esp. mal adapt.
Ord. Fulgensietalia desertori	10.41	24.04	1.00	9.42	2.55	Gr. esp. bien adapt.
Cl. Psoretea decipientis	17.20	39.71	5.23	49.29	0.80	Gr. esp. +/- adapt.
Acompañantes						
	2.72	6.26	1.77	16.68	0.37	Gr. esp. mal adapt.

Tabla 4. Verrucarietum cazzae

Localización de los inventarios: 1. Denia: Sierra del Montgó. BD4900. Zona basal de un conjunto de pequeños bloques de roca caliza diaclasados, junto al suelo. 2. Como el nº 1 pero en una pared de roca caliza compacta. 3. Calpe: Peñón de Ifach. BC4580. Parte superior inclinada en un bloque de roca caliza a 1 m del suelo. 4. Calpe: Morro del Toix. BC4179. Cara superior de un bloque de roca calizo-dolomítica muy compacta. 5. Como el nº 4 pero 20 m más al Este.

Síntesis de las características de los inventarios: Altitud: máxima 500 m, media 230 m, mínima 100 m. Orientación: 80 % al NE, 20 % al N. Inclinación: máxima 85°, media 71°, mínima 60°. Recubrimiento: máximo 100 %, medio 83 %, mínimo 55 %.

Tabla 6. Comunidad de Solenopsora cesatii y Solenopsora olivacea var. olivacea

Localización de los inventarios: 1. Denia: Sierra del Montgó. BD4900. Superficie vertical de un conjunto de bloques calizos, que determinan un escalón por donde discurre una rambla, con frecuentes oquedades, a 1 m del suelo. 2. Como el nº 1 pero en el lado vertical de un escalón rocoso en la base de una gran pared de caliza compacta a 50 cm del suelo. 3. Cartagena: Sierra de la Muela. XG6861. Superficie fuertemente inclinada de caliza compacta con orientación N. 4. Como el nº 3 pero en un gran bloque dolomítico junto al camino, orientado al NE. 5. Como el nº 1 pero en una superficie inclinada de un gran bloque rocoso calizo desprendido. 6. Cartagena: Cabo Tiñoso. XG6457. Superficie inclinada en la arista de un bloque calizo-margoso a 2 m del suelo con orientación N. 7. Aguilas: Cabo Cope. XG3443. Pared de caliza compacta. 8. Como el nº 2 pero con orientación N.

Síntesis de las características de los inventarios: Altitud: máxima 450 m, media 278.75 m, mínima 80 m. Orientación: 50 % al N, 37.5 % al NE, 12.5 al NW. Inclinación: máxima 90°, media 78.75°, mínima 60. Recubrimiento: máximo 95 %, medio 86.25 %, mínimo 80 %.

Tabla 8. Comunidad de Rinodina immersa

Localización de los inventarios: 1. Benidorm: Sierra Helada. YH5369. Superficie vertical de un conjunto de bloques calizos, que determinan escalones, a 1 m del suelo. 2. Denia: Sierra del Montgó. BD4900. Superficie inclinada con abundantes oquedades en la parte inferior de una arista soleada e intensamente nitrificada. 3. Como el nº 1 pero en una superficie inclinada de roca caliza diaclasada intensamente soleada. 4. Como el nº 2 en una pared vertical de caliza compacta a 1 m del suelo.

Síntesis de las características de los inventarios: Altitud: máxima 500 m, media 205 m, mínima 30 m. Orientación: 50 % al N, 25 % al W, 25 % al SW. Inclinación: máxima 85°, media 73.75°, mínima 60°. Recubrimiento: máximo 100 %, medio 95 %, mínimo 90 %.

Tabla 9. Comunidad de Aspicilia calcarea y Xanthoria calcicola

Localización de los inventarios: 1. Calpe: Peñón de Ifach.

BC4580. Arista de roca caliza inclinada. 2. Denia: Sierra del Montgó. BD4900. Arista muy inclinada de roca caliza a 1.5 m del suelo. 3 y 24. Benidorm: Sierra Helada. YH5369. Superficie superior de un pequeño bloque calizo, más o menos plano, prácticamente a ras de suelo. 4 y 23. Cartagena: La Azohía. XG6258. Superficie muy inclinada en la base de una pared de roca caliza. 5. Como el nº 1 pero en una superficie más inclinada y con orientación SE. 6. Como el nº 2 pero en una arista horizontal en roca caliza a 2 m del suelo. 7. Denia: Torre del Charro BD5301. Superficie superior de un bloque calizo a 1.5 m del suelo. 8 y 12. Cartagena: Cabezo El Cambrón XG6361. Arista soleada horizontal a 1 m del suelo. 9. Como el nº 7 pero en el extremo superior de un bloque calizo. 10. Como el nº 1 pero en una arista soleada con inclinación variable de 0 a 60°. 11. Como el nº 2 pero con orientación N. 13. Como el nº 3 pero en una arista con inclinación de 10 a 20°. 14. Como el nº 2 pero en una superficie calcárea, más o menos plana, con diaclasas y oquedades. 15. Como el nº 2 pero con orientación E. 16. Jávea: Cabo de la Nao. BC5991. Arista de roca caliza con oquedades y con inclinación variable de 10 a 30°. 17. Jávea: Cabo de San Antonio. BC5799. Arista rocosa a 2 m del suelo en el borde de un acantilado. 18. Como el nº 1 pero en una superficie calcárea casi plana, en un bloque rocoso a 50 cm del suelo. 19. Como el nº 18 pero con orientación W y 20 m más al E. 20. Como el nº 2 pero en una arista plana. 21. Como el nº 20 pero en una arista inclinada con orientación SE. 22. Como el nº 18 pero con orientación E. 25. Como el nº 4 pero en un gran bloque de roca en el suelo. 26. Villajoyosa: Torre de Playa Parais. YH4065. Superficie de roca caliza-margosa inclinada, en la parte inferior de un gran bloque. 27 y 28. Como el nº 16 pero en una superficie plana de roca caliza.

Síntesis de las características de los inventarios: Altitud: máxima 550 m, media 193.75 m, mínima 20 m. Orientación: 32.14 % al NE, 21.42 % al E, 17.85 % al N, 10.71 % al SE, 10.71 % al W, 7.14 % al S. Inclinación: máxima 80°, media 34.28°, mínima 5°. Recubrimiento: máximo 100 %, medio 84.28 %, mínimo 50 %.

Tabla 11. Dirinetum repandae

Localización de los inventarios: 1. Aguilas: Cabo Cope. XG3147. Superficie muy inclinada en rocas calizas diaclasadas a 2 m del suelo. 2. Marruecos. Al-Hoceima: carretera de la costa. Superficie vertical en dunas fósiles a 4 m del suelo. 3. Denia: Sierra del Montgó. BD4900. Superficie vertical en una pared de caliza compacta a 5 m del suelo. 4. Marruecos. Mirhleft: Entre Gourizim y Mirhleft. Superficie muy inclinada en un bloque de caliza-margosa. 5. Cartagena: Sierra de la Muela. XG6861. Pared irregularmente vertical de calizas compactas. 6. Como el nº 5 pero en superficie vertical y a 200 m más al Este. 7. Almuñécar, La Herradura: Punta de la Mona. VF6535. Base de pared vertical de caliza compacta. 8. Cabo Palos: Cabezo de la Fuente. XG9764. Superficie vertical en rocas calizas a 2 m del suelo. 9. Cartagena: Cabezo El Cambrón. XG6361. Pared vertical de caliza compacta. 10. Mazarrón: Sierra de las Moreras. XG4960. Superficie fuertemente inclinada de rocas calizas diaclasadas. 11. Calpe: Peñón de Ifach. BC4580. Superficie vertical en una pared de calizas compactas. 12. Marruecos. Ras-el-Mara: Cap de l'eau. Superficie vertical en rocas calcarenitas que constituyen diversos escalones a 25 cm del suelo. 13. Almuñécar. La Herradura: Cerro Gordo. VF6530. Base de una pared vertical de caliza compacta. 14 y 21. Jávea: Cabo de la Nao. BC5991. Pequeños bloques

calizos escalonados en acantilado costero. 15 y 19. Cabo de Palos: Faro del Cabo de Palos. YG0368. Superficie subextraplomada en pequeños bloques calizos superpuestos. 16. Como el nº 3 pero en una pared vertical de caliza muy compacta situado en la base de un circo rocoso. 17. Como el nº 3 pero con orientación NE. 18. Como el nº 11 pero en una superficie subextraplomada con orientación NE. 20. Almería: Proximidades del Puente del Cura. WF7643. Superficie subextraplomada en un pequeño bloque rocoso de calizas diaclasadas a 50 cm del suelo. 22. Jávea: Cabo de San Antonio. BC5799. Entrante poco profundo en la base de un gran bloque de rocas calizas compactas. 23. Almería: Punta de los Muertos. UTM WF 9990. Entrante poco profundo en la base de un bloque de areniscas calcáreas a 2 m del suelo. 24. Como el nº 23, 20 m más al este. 25. Santa Pola. Cabo de Santa Pola YH1832. Pequeño bloque de caliza-margosa muy diaclasada. 26. Cartagena: La Azohía. XG6258. Superficie vertical en un bloque de calizas cristalizadas.

Síntesis de las características de los inventarios: Altitud: máxima 350 m, media 127.69 m, mínima 10 m. Orientación: 53.85 % al N, 46.15 % al NE. Inclinación: máxima 120°, media 95.57°, mínima 80°. Recubrimiento: máximo 100 %, medio 94 %, mínimo 70 %.

Tabla 13. Comunidad de *Xanthoria resendei*

Localización de los inventarios: 1. Almería: Proximidades del Puente del Cura. WF7643. Arista soleada inclinada, de roca caliza a 1.5 m del suelo. 2. Murcia: Cabo Cope. XG3443. Superficie inclinada con abundantes fisuras en la parte inferior de una arista soleada e intensamente nitrificada.

Tabla 14. Comunidad de *Heppia solorinoides* y *Psora vallesiaca*

Localización de los inventarios: 1. Turre: Sierra de Cabrera. WG9408. Suelo muy compacto, seco y soleado con un recubrimiento en fanerógamas del 20 %. 2. Almuñécar: La Herradura, Cerro Gordo. VF6530. Suelo con abundantes piedras, compacto, con un 5 % de recubrimiento en fanerógamas. 3. Aguilas: Cabo Cope. Las Casicas. XG3147. Suelo horizontal desnudo y compacto. 4. Como el nº 1 pero en posición horizontal. 5. Como el nº 3 con un recubrimiento en vegetación superior del 30 %. 6 y 7. Pulpí: Cala Reona. Suelo compacto y duro con vegetación superior escasa. 8. Cabo de Palos: Monte de las Cenizas. XG9261. Superficie casi horizontal con un 30 % de musgos y 40 % en recubrimiento de fanerógamas. 9. Como el nº 8 pero con orientación E. 10. Portugal. Algarve. Lagoa: Cabo Carboeiro. Superficie horizontal en suelo compacto y duro. 11. Como el nº 8 pero en una ladera orientada al N con abundantes piedras y sombreado. 12. Como en nº 8 pero en superficie horizontal en suelo desnudo junto a tomillos que sólo recubren el 10 %. 13. Cartagena: Cabezo El Cambrón. XG6361. Superficie inclinada en suelo compacto, pedregoso con vegetación superior que recubre un 40 %.

Síntesis de las características de los inventarios: Altitud: máxima 330 m, media 149.6 m, mínima 20 m. Orientación: 53.84%, 15.38% al NE, 7.69% al SE, 7.69% al W, 7.69% al N, 7.69% al S. Inclinación: máxima 50°, media 8.84°, mínima 0°. Recubrimiento: máximo 90%, medio 73.84%, mínimo 50%.

Bibliografía

- Alonso F. L., 1987. *Estudio de la Flora y Vegetación líquénica calcícola del litoral: desde Cullera (Valencia) hasta Torreveja (Alicante); SE de la Península Ibérica*. Tesis de Licenciatura, inéd. Universidad de Murcia.
- Baeza M.J., 1989. *Estudio de la Flora y Vegetación líquénica de la Sierra de Espuña (Murcia). SE de España*. Tesis de Licenciatura, inéd. Universidad de Murcia.
- Boqueras M., Navarro-Rosinés P. & Gómez-Bolea A., 1989. *Flora y Vegetación Liqueñica nitrófila del Delta de l'Ebre*. Bull. Inst. Cat. Hist. Nat., 57 (Sec. Bot., 7): 41-52.
- Bouderesque C.F., 1970. *Recherches sur les concepts de biocenose et de continuum au niveau de peuplements benthiques sciaphiles*. Vie et Milieu, 21 (1B): 103-136.
- Bouderesque C.F., 1971. *Méthodes d'étude qualitative et quantitative du benthos (en particulier du phytobenthos)*. Tethys, 3(1): 79-104.
- Casares M., 1984. *Investigaciones liquenológicas en las rocas carbonatadas de la provincia de Granada*. Tesis doctoral inéd., Universidad de Granada.
- Casares M. & Llimona X., 1986. *La clase Verrucarietea nigrescentis Wirth 1980 en las calizas béticas de la provincia de Granada*. Cryptogamie. Bryol. Lichénol., 7 (2): 103-127.
- Clauzade G. & Roux C., 1975. *Etude écologique et phytosociologique de la végétation lichénique des roches calcaires non altérées dans la Région Méditerranéenne du Sud-Est de la France*. Bull. Mus. Hist. Nat. Marseille, 35: 153-208.
- Clauzade G. & Roux C., 1985. *Likenoj de Okcidenta Euroapo. Ilustrita Determinlibro*. Bull. Soc. Bot. Centre-Ouest, n.s.,nr. spéc., 7: 1-893.
- Egea J.M., 1989. *Las comunidades líquénicas saxícolas, ombrofobas, litorales del suroeste de Europa y norte de Africa (Roccelletea phycopsis classis prov.)*. Studia Geobot., 9: 73-152.
- Egea J.M. & Llimona X., 1982. *Los líquenes silícícolas de la Sierra del Cabo de Palos: Estudio Florístico, Fitosociológico y Ecológico*. Acta Bot. Malac., 7: 11-38.
- Egea J.M. & Llimona X., 1984. *Las comunidades líquénicas saxícolas ombrofobas de la costa del SE de España comprendidas entre el Penyol d'Ifac (Alicante) y Almería*. Coll. Bot., 15: 205-219.
- Egea J.M. & Llimona X., 1987. *Las comunidades de líquenes de las rocas silíceas no volcánicas del SE de España*. Acta Bot. Barcin., 36: 1-123.
- Egea J.M. & Llimona X., 1991. *Phytogeography of silicicolous lichens in mediterranean Europe and NW Africa*. Bot. Chron., 10: 179-198.
- Feige G. B. & Lumbsch H. T., 1993. *A European species of the Lichen genus Ingaderia and comments on the relationship of the genera Darbishirella and Ingaderia (Roccellaceae)*. Mycotaxon, 48: 381-387.
- Hadač E., 1944. *Společenstva tajnosubných rostlin*. In: Klika J. & Hadač E. (eds.): *Rostlinná společenstva střední Evropy Priroda*. 36, 8/9. Separ. S. 1-9.
- Klement O., 1950. *Zur Flechtenvegetation der Oberpfalz*. Ber. Bayer. bot. Ges. München, 28: 1-26.
- Klement O., 1955. *Prodromus der mitteleuropäischen Flechtengesellschaften*. Feddes Report 135: 5-194.
- Klement O., 1965. *Flechtenflora und Flechtenvegetation der*

- Phytiusen*. Nova Hedw., 9 (1-4): 435-501.
- Llimona X., 1975. *Xanthoria resendei* Poelt et Tavares, en el SE de España; fitosociología y ecología. An. Inst. Bot. Cav., 32 (2): 909-922.
- Llimona X. & Egea J. M., 1984. *La vegetación líquénica saxícola de los volcanes del Mar Menor (Murcia, SE de España)*. Bull. Inst. Cat. Hist. Nat. (sec. Bot., 5), 51: 77-99.
- Llimona X. & Egea J. M., 1985. *Las comunidades líquénicas de las superficies de escorrentía de las rocas silíceas mediterráneas*. An. Jard. Bot. Madrid, 41(2): 429-444.
- Merino A., 1981. *Líquenes de las rocas calizas pontienses del SE de la provincia de Madrid entre los ríos Henares y Tajuña*. Tesis de Licenciatura, inéd. Universidad Autónoma de Madrid.
- Moreno P. P. & Egea J. M., 1991a. *Biología y taxonomía de la familia Lichinaceae, con especial referencia a las especies del SE Español y Norte de Africa*. Secretariado de Publicaciones, Universidad de Murcia, 87 pp.
- Moreno P. P. & Egea J. M., 1991b. *On a new lichen community with Thyrea girardi and Anema nummularium*. Bot. Chron., 10: 969-975.
- Navarro-Rosinés P., 1992. *Els Lliquens i Els Fongs Lliquenicoles dels substrats carbonatats de Catalunya meridional*. Tesis doctoral, ined. Universidad de Barcelona.
- Nimis P.L., 1993. *The Lichens of Italy. An annotated catalogue*. Museo Regionale Scienze Naturali, Torino, 897 pp.
- Poelt J. & Vezda A., 1981. *Bestimmungsschlüssel europäischer Flechten*. Ergänzungsheft II. J. Cramer, Vaduz, 389 pp.
- Purvis O.W., Coppins B.J., Hawksworth D.L., James P.W. & Moore D.M. (eds.), 1992. *The Lichen Flora of Great Britain and Ireland*. Natural History Museum Publications & The British Lichen Society, London, 710 pp.
- Roux C., 1978. *Complément à l'étude écologique et phytosociologique des peuplements lichéniques saxicoles-calciocoles du SE de la France*. Bull. Mus. Hist. Nat. Marseille, 38: 65-186.
- Roux C., 1991. *Phytogéographie des lichens saxicoles-calciocoles d'Europe méditerranéenne*. Bot. Chron., 10: 163-178.
- Roux C. & Egea J. M., 1992. *L'Opegraphetum duriei Egea et Roux ass. nov., une association lichénique saxicole-calciocole, halophile*. Cryptogamie, Bryol. Lichénol., 13(2): 105-116.
- Werner R. G., 1932. *Contribution à la flore cryptogamique du Maroc*. V. Cavanillesia, 5(5): 157-174.
- Werner R. G., 1979. *La flore lichénique de la cordillère bético-rifaine. Etude de phytogéographie et écologique*. Collect. Bot., 11: 401-463.
- Wirth V., 1980. *Flechtenflora. Ökologische Kennzeichnung und Bestimmung der Flechten Südwestdeutschlands und angrenzender Gebiete*. [Uni-Taschenbücher no. 1062]. E. Ulmer, Stuttgart, 552 pp.

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NEW OR INTERESTING LICHENS FROM THE DOLOMITES (TRE CIME DI LAVAREDO, NE ITALY)

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Keywords: Alps, Dolomites, Flora, Lichens.

Abstract: Seventy-five infrageneric taxa of lichens are reported from the Dolomites (NE Italy, Tre Cime di Lavaredo). The samples were collected in two stations, one in the Alpine belt (2300-2400 m), the other in the subalpine belt (1800 m). Seventeen taxa are new to the Region of Veneto; eight of these are also new to the lichen flora of Italy; these are: *Caloplaca isidiigera* Vezda, *Candelariella unilocularis* (Elenk.) comb. nov., *Candelariella plumbea* Poelt & Vezda, *Eiglera homalomorpha* (Nyl.) Clauz. & Roux, *Farnoldia jurana* ssp. *bicincta* (Hertel) Clauz. & Roux, *Lecanora meolansii* B. de Lesd., *Verrucaria zamenhofiana* Clauz. & Roux., *Xanthoria elegans* v. *orbicularis* (Schaerer) Clauz. & Roux.

Introduction

Northern Italy, with 1857 species, is one of the lichenologically richest areas in Europe (Nimis 1993). The high number of species is mainly due to the presence of the Alpine chain, with a great diversity of substrates and of climatic types. The degree of lichenological exploration of the Italian Alps, however, is still very unsatisfactory. Most of the lichen records are due to the intensive exploration of relatively narrow areas by lichenologists of the previous century. The main contributions are those of Anzi (1860) for the Province of Sondrio in Lombardy, Baglietto (1857) for Liguria, Baglietto and Carestia (1880) for the Valsesia in Piedmont, and Arnold (1868-1897) for South Tyrol. During this century, due to the profound crisis of lichenology in Italy (Nimis 1988), no detailed floristic study concerning the Italian Alps was ever carried out. Only in more recent times several scattered records were published by various authors (e.g. Buschardt 1979, Tretiach 1993). On the whole, most of the Italian Alps still awaits a detailed lichenological exploration.

During the summer of 1994 I organized the international excursion of the Association Francaise de Lichénologie to the eastern Alps. Among the localities which were visited during the excursion there was the area of the Tre Cime di

Lavaredo, in the Dolomites (Prov. Belluno). The short time available did not allow a detailed study of the local flora. However, also thanks to the presence of several specialists, and especially of C. Roux and Ch. van Haluwyn, which drew my attention to some recently-described or poorly-known taxa, it was possible, in a few hours, to collect several interesting lichens.

With the publication of this note I would like to present an example of how profitable it would be to carry out detailed lichenological studies in the Italian Alps. The paper includes a list of 75 infrageneric taxa collected in two localities, one in the Alpine, the other in the subalpine belt; 17 taxa are new to the region of Veneto, 8 taxa are new to the lichen flora of Italy.

Survey area, Data and Methods

The survey area is located in the heart of the Dolomites (NE Italy, Region of Veneto, Prov. Belluno), and includes two localities on the southern slopes of one of the most impressive and famous dolomitic Massives, the Tre Cime di Lavaredo.

Station A: Near Rifugio Auronzo, ca. 2,300-2,400 m, open Alpine grasslands with plenty of dolomitic boulders.

Station B: road from Rifugio Auronzo to Misurina, 1.800 m, very open *Larix* and *Pinus cembra* stand, with a dense undergrowth of *Pinus mugo* and, in acid soil pockets, of *Rhododendron ferrugineum*.

The samples are preserved in the Herbarium Universitatis Tergestinae (TSB, Herb. Nimis).

Nomenclature follows Nimis (1993).

Floristic List

Acarospora macrospora (Hepp) Bagl. - On sun-exposed, steeply inclined surfaces of dolomitic boulders, not common. For Veneto the species was known only from a single record in the area surrounding Bassano (Beltramini 1858). (A).

Alectoria ochroleuca (Hoffm.) Massal. - On wind-swept ridges, rather rare. (A).

Arthonia lapidicola (Taylor) Branth. & Rostr. - On small boulders and pebbles, in rather sheltered situations, locally common. (A).

Caloplaca cerina v. *chloroleuca* (Sm.) Th. Fr. - Very common on mosses and plant debris. (A, B).

Caloplaca diphyodes (Nyl.) Jatta - On a dolomitic rocks, in a rather shaded situation in the Alpine belt. This, the only representative of the *C. variabilis* complex occurring on siliceous substrata, may also grow on dolomitic rocks. Our samples are quite typical, and were compared with a sample from the Carnic Alps (Friuli), M. Poludnig, 2000 m, collected and identified by J. Poelt (GZU, TSB). New to Veneto and to Friuli. (A).

Caloplaca epiphyta Lyngé - Rather common on mosses and plant debris, especially in rather sheltered, but eutrophicated situations near the top of isolated boulders. This species, which for Italy is known only from the Dolomites, is certainly much more widespread in the calcareous Alps; it has been probably mistaken for the superficially similar *Caloplaca citrina*. (A).

Caloplaca isidiigera Vezda - On isolated dolomitic boulders in rather nutrient-enriched situations, often starting the life-cycle as a parasite of other lichens. The species is, at least formally, new to Italy. However, it might be (see Purvis & al. 1994) that the epithet *C. chlorina* (Flotow) Sandst. is an earlier name for this lichen. If this would prove to be the case, it is most probable that, of the records cited by Nimis (1993) for Italy, those from Lombardy and Piedmont refer to this lichen, whereas most of the others from peninsular and insular Italy could refer to another taxon in the *Caloplaca cerina* complex, which is devoid of isidioid outgrowths. New to Italy. (A).

Caloplaca proteus Poelt - On rather sheltered, steeply inclined surfaces, not rare. For the Region of Veneto the species was known from one locality only (Nordin 1972). (A).

Caloplaca sinapisperma (Dc.) Mah. & Gill. - On mosses and plant debris, not uncommon. (A).

Caloplaca tirolensis Zahlbr. - Not uncommon on mosses and plant debris, especially dead leaves of *Saxifraga*. New to Veneto. (A).

Candelariella unilocularis (Elenk.) comb. nov. Basion.: *Candelariella cerinella* v. *unilocularis* Elenk., Lich. Flor. Rossiae Mediae, fasc. 2: 273, 1907 - This Arctic-Alpine lichen, which occurs on mosses and plant debris on carbonatic substrata, and, more rarely, directly on rocks, is, in my opinion, well worth of being separated from *C. aurella* as a distinct species. It differs from *C. aurella* s.str. in having a well-developed thallus, in the much larger apothecia and the much larger spores. It is widespread, and sometimes common, throughout the calcareous Alps. New to Italy. (A).

Candelariella plumbea Poelt & Vezda - This species, which belongs in the form-rich group of *C. aurella* s. lat., is very characteristic: it grows directly on limestone and dolomite in rather exposed and eutrophicated situations, and is characterized by a thick, grey thallus. In the original description the thallus is said to be isidiate-sorediate: I have analyzed several samples in GZU: some of them actually have rough, corticate, isidia-like protuberances; many, however, have a more or less smooth thallus. I am not certain that the grey thallus belongs to the *Candelariella*; the species might be parasitic on sterile, grey thalli of other lichens, as already suggested by Clauzade & Roux (1985) for *C. oleaginescens* v. *glebulosa*, which is a most probable synonym of *C. plumbea*. *C. plumbea* is widespread and locally common in the eastern Alps, especially in the Alpine belt. New to Italy. (A).

Catapyrenium daedaleum (Krempelh.) B. Stein. - On soil in open vegetation. This species is frequent in the calcareous eastern Alps, especially in the Alpine belt. (A).

Cetraria islandica (L.) Ach. - Very common and abundant in subalpine vegetation. (B).

Cladonia amaurocraea (Flörke) Schaerer - Rather rare amongst *Rhododendron*-shrubs in the subalpine belt. (B).

Cladonia arbuscula (Wallr.) Flotow - Common in the subalpine belt. (B).

Cladonia bellidiflora (Ach.) Schaerer - Rather rare, in the subalpine belt. (B).

Cladonia coccifera (L.) Willd. - Common, especially in the subalpine belt, with fruiting specimens, mostly sterile in the Alpine belt. (A, B).
Cladonia crispata (Ach.) Flotow - Rather rare, in the subalpine belt, on acid ground. (B).
Cladonia gracilis (L.) Willd. - Not very frequent, in the subalpine belt. (B).
Cladonia macroceras (Delise) Havaas - Very common and often abundant, especially amongst mosses in subalpine *Rhododendron* formations. (B).
Cladonia pocillum (Ach.) O.J. Rich. - On bare, mineral soil in the Alpine belt; our specimens are quite typical. (A).
Cladonia pyxidata (L.) Hoffm. - Most common in the subalpine belt, on bare soil. (A, B).
Cladonia rangiferina (L.) Wigg. - Mostly in the subalpine belt, where it is common, and often associated with *Cladonia arbuscula*. (B).
Cladonia squamosa (Scop.) Hoffm. - Rather rare, but very well-developed, on bare soil in the subalpine belt. (B).
Collema polycarpon Hoffm. - On dolomitic boulders, common. (A).
Dermatocarpon miniatum (L.) Mann - On dolomitic boulders, often in fissures or in sites with periodical percolation of water, common. (A, B).
Eiglera flavida (Hepp) Haf. - On dolomitic boulders and pebbles in the Alpine belt, not frequent, but locally abundant. For Veneto there was a single record from the previous century (Arnold 1876). (A).
Eiglera homalomorpha (Nyl.) Clauz. & Roux - On shaded dolomitic boulders, common and often abundant. This species, previously called *Lecidea cavatula* Nyl., has been often overlooked by previous authors; it is fairly common and often abundant in the calcareous eastern Alps, from the Dolomites to the Julian Alps, especially above tree limit. New to Italy. (B).
Farnoldia jurana (Schaerer) Hertel ssp. *jurana* - Common on dolomitic rocks (A, B).
Farnoldia jurana ssp. *bicincta* (Hertel) Clauz. & Roux - On dolomitic boulders, found only once. This subspecies is characterized by the umbonate apothecia. New to Italy. (A).
Hypogymnia farinacea Zopf - On *Pinus cembra* in the subalpine belt, rather common. (B).
Hypogymnia physodes (L.) Nyl. - Very common in the subalpine belt, on *Larix* and *Pinus cembra*. (B).
Icmadophila ericetorum (L.) Zahlbr. - Very common in the subalpine belt, on rotten wood and dying *Sphagnum* mats. (B).

Imshaugia aleurites (Ach.) S.F. Meyer - On *Larix* and *Pinus cembra* in the subalpine belt, frequent. (B).
Ionaspis heteromorpha (Krempelh.) Arnold - On dolomite in rather shaded situations, often near the ground, not rare. For Italy the species was previously known only from South Tyrol (Nimis 1993). New to Veneto. (A).
Ionaspis melanocarpa (Krempelh.) Arnold - Together with the previous species, and perhaps more common. (A).
Lecanora dispersa (Pers.) Sommerf. - On cement walls in the Alpine belt. (A).
Lecanora epibryon (Ach.) Ach. - Very common on mosses and plant debris in the Alpine belt. (A).
Lecanora meolansii B. de Lesd. - On isolated dolomitic boulders in the Alpine belt. This taxon, belonging to the difficult and still poorly understood complex of *Lecanora dispersa* s.lat., is characterized by the presence of blue pigments reacting N+ red in the amphithecial cortex and sometimes also on the epithecium. Such forms are quite common in the Alpine belt of the calcareous Eastern Alps. The taxonomical value of the presence of pigments is still not clear to me: sometimes pigmented and non-pigmented apothecia occur side by side. As, however, these samples appear to be different from *L. dispersa* s.str. also in many other minor traits, I prefer to accept here *L. meolansii* as a distinct species, pending a general revision of the *L. dispersa* group. The species is, at least formally, new to Italy; according to Poelt (*in litt.*), several records of *L. dispersa* v. *coniotropa* by Arnold, from South Tyrol, refer to *L. meolansii*. In TSB there is another sample from Friuli (Carnic Alps), collected by J. Poelt at M. Poludnig, at c. 2000 m (dupl. GZU), representing a form with non-pruinose apothecia. (A).
Lecanora varia (Hoffm.) Ach. - On decorticated stumps of *Larix* and *Pinus cembra* in the subalpine belt, rather frequent. (B).
Lecidella patavina (Massal.) Knoph & Leuck. - A widespread and rather common species of carbonatic rocks. (A).
Mycobilimbia hypnorum (Libert) Kalb & Haf. - On mosses and plant debris, rather frequent. (A).
Mycobilimbia lobulata (Sommerf.) Haf. - On mosses and plant debris, not as common as the previous species. (A).
Pannaria pezizoides (G.H. Weber) Trevisan - On epigeaic mosses in the Alpine and subalpine belts, common and often abundant. (A, B).

Parmelia omphalodes (L.) Ach. - On an isolated boulder with siliceous nodules. Rare. New to Veneto. (A).

Parmeliopsis ambigua (Wulfen) Nyl. - At the basis of trunks of *Larix* and *Pinus cembra*, as well as on stumps, common. (B).

Parmeliopsis hyperopta (Ach.) Arnold - As the previous species, but not as frequent; perhaps more abundant in rather shaded situations. (B).

Peltigera didactyla (With.) Laundon - On bare soil, rare. (A).

Peltigera lepidophora (Nyl.) Bitter - A Boreal-montane species in Europe (Vitikainen 1995), which, in spite of the few records (Nimis 1993), is not rare in the eastern Alps. New to Veneto. (A).

Peltigera rufescens (Weis) Humb. - On bare, mineral soil, common. (A).

Phaeophyscia sciastra (Ach.) Moberg - On the top of isolated dolomitic boulder, in nutrient-rich situations, common. (A).

Phaeorrhiza nimbosea (Fr.) H. Mayrh. & Poelt - On soil, mosses and decaying plants on isolated, exposed boulders, common and often abundant. (A).

Physconia muscigena (Lam.) Poelt - On mosses and plant debris in nutrient-enriched situations, especially at the top of isolated dolomitic boulders. (A).

Polyblastia sendtneri Krempelh. - On plant debris on a dolomitic boulder. This Arctic-Alpine species was previously known for Veneto only from an old record by Arnold (1876). (A).

Protoblastenia siebenhaariana (Koerber) Steiner - On dolomite, not common. Previously known for Veneto only from an old record by Arnold (1876). (A).

Pseudevernia furfuracea (L.) Zopf - Common and abundant on *Larix* and *Pinus cembra* in the subalpine belt. (B).

Rhizocarpon umbilicatum (Ram.) Flagey - Rather common on exposed dolomitic rocks. (A).

Rinodina castanmelodes H. Mayrh. & Poelt - On dolomite. A recently-described, Arctic-Alpine species of limestone, marl and calcareous schists. New to Veneto. (A).

Rinodina mniaraea (Ach.) Koerber - Common on plant debris and mosses. Previously known for Veneto only from an old record by Arnold (1876). (A).

Rinodina roscida (Sommerf.) Arnold - On decaying mosses on a dolomitic boulder. An Arctic-Alpine lichen, widespread throughout the Alps, but new to Veneto. (A).

Saccomorpha icmalea (Ach.) Clauz. & Roux - On recently disturbed organic soil in the subalpine belt, very common. This species was forgotten for a long time, and was often confused with *S. uliginosa* (Schrader) Haf. There were no previous records from Northern Italy, where this lichen is certainly much more common and widespread than hitherto assumed, especially in the Alps. New to Veneto. (B).

Sarcogyne pruinosa v. *platycarpoides* (Anzi) Magnusson - On steeply inclined surfaces of a dolomitic boulder in the Alpine belt. This variety, characterized by the large, partially immersed apothecia with a thin margin, is certainly worth of further studies, like many other forms in the *S. pruinosa*-complex. New to Veneto. (A).

Sarcosagium campestre (Fr.) Poetsch & Schied. - On terricolous mosses, found only once. This Boreal-montane species is known for Italy only from a few records, but is probably more widespread, at least in the Alps, being very easy to overlook. (A).

Solorina bisporea Nyl. - Only an ancient record from the Dolomites (Arnold 1876), where, however the species is widespread and even common, especially in the Alpine belt: it was confused with *S. saccata*. (A).

Solorina saccata (L.) Ach. - Common, especially in the subalpine belt. (A, B).

Squamarina lamarckii (DC.) Poelt - On steeply inclined surfaces of dolomitic rocks, often in fissures, not frequent. (A).

Staurothele areolata (Nyl.) Vainio - Very common on dolomitic boulders, in rather nutrient-enriched situations, especially in the Alpine belt. The species is widespread in the eastern Alps. (A, B).

Thelidium decipiens (Nyl.) Krempelh. - Common on rock in the Alpine belt. (A).

Toninia alutacea (Anzi) Jatta - In fissures of steeply inclined dolomitic rocks, rather common. (A).

Verrucaria tristis (Massal.) Clauz. & Roux - This characteristic species seems to be very common, especially in the Alpine belt, on dolomitic boulders, and in slightly sheltered situations. For the Dolomites the species was known only from an old record by Arnold (1876). (A, B).

Verrucaria zamenhofiana Clauz. & Roux - This recently-described species is quite easy to overlook, being a parasite inside the thalli of *Staurothele areolata*. In the Alpine belt it seems to be quite common. New to Italy. (A).

Xanthoria elegans (Link) Th.Fr. - On isolated

dolomitic boulders in nutrient-enriched situations, common. (A).

Xanthoria elegans v. *orbicularis* (Schaerer) Clauz. & Roux - On dolomitic boulders, together with *X. elegans* s.str., and clearly different from it at first sight, without any transitional form. This variety is characterized by more or less flat, broad (2-3.5 mm), short lobes; among the various forms of the very polymorphic *X. elegans* s.lat. this is probably the one which would be most worth of further studies. New to Italy. (A).

Xylographa abietina (Pers.) Zahlbr. - On decorticated stumps of *Larix* and *Pinus cembra* in the subalpine belt, frequent. From Veneto there was just an old record (Arnold 1876), but the species is widespread and often common throughout the Alps. (B).

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References

- Anzi M., 1860. *Catalogus lichenum quos in Provincia Sondriensi collegit et ordinavit et in ordinem systematicum digessit presbyter M. Anzi*. Novi Comi. Tip. C. Franchi. 126 pp.
- Anzi M., 1866. *Neosymbola lichenum rariorum vel novorum Italiae superioris*. Atti Soc. Ital. Sc. Nat. Milano, 9: 241-258.
- Arnold F., 1876. *Lichenologische Ausflüge in Tirol*. XVI. Ampezzo. Verh. zool.-bot. Ges. Wien, 26: 389-414.
- Baglietto F., 1857. *Enumerazione dei licheni di Liguria*. Mem. R. Acc. Sc. Torino, ser. 2, 17: 343-444.
- Baglietto F. & Carestia A., 1880. *Anacrisi dei Licheni della Valsesia*. Atti Soc. Critt. Ital., 2 (2-3): 143-356.
- Beltramini de' Casati F., 1858. *Licheni Bassanesi enumerati e descritti*. Roberti, Bassano. 313 pp.
- Buschardt A., 1979. *Zur Flechtenflora der Inneralpinen Trockentäler unter besonderer Berücksichtigung des Vinschgaus*. Bibl. Lichenol., 10. 419 pp.
- Clauzade G. & Roux C., 1985. *Likenoj de Okcidenta Europo. Ilustriita Determinlibro*. Bull. Soc. Bot. Centre-Ouest, n. s., nr. spéc. 7. 893 pp.
- Nimis P.L., 1988. *La crisi della Lichenologia in Italia dalla fine dell'800 ad oggi*. In: Pedrotti F. (ed.), 100 anni di ricerche botaniche in Italia (1888-1988). Soc. Bot. Ital. Firenze, 397-405.
- Nimis P.L., 1993. *The lichens of Italy. An Annotated Catalogue*. Mus. Reg. Sci. Nat. Torino, Monogr. XII, 897 pp.
- Nordin I., 1972. *Caloplaca sect. Gasparrinia i Nordeuropa. Taxonomiska och ekologiska studier*. Skriv Service AB. Uppsala. 184 pp.
- Purvis O.W., Coppins B.J., Hawksworth D.L., James P.W. & Moore D.M. (eds.), 1992. *The Lichen Flora of Great Britain and Ireland*. Nat. Hist. Mus. Publ., London, 710 pp.
- Tretiach M., 1993 (1992). *Lichenological studies in NE-Italy. V. New records from Friuli-Venezia Giulia*. Studia Geobot., 12: 3-60.

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KARYOLOGICAL STUDIES OF *SPARTOCYTISUS* WEBB & BERTH. (*GENISTEAE* - *FABACEAE*)

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Keywords: *Genisteeae*, *Fabaceae*, *Cytisus*, Karyological analysis, *Spartocytisus*, Canary Islands.

Abstract: A karyological analysis of the two species of *Spartocytisus* (*S. filipes* and *S. supranubius*) was carried out. Both species have the same chromosome number $2n=48$. *S. nubigenus* shows a number of accessory chromosomes varying from 0 to 4, with a maximum frequency of 2. In addition, a comparison was made with the karyological data already available for the taxa of the *Cytisus*-group and for other intermediate genera of the *Genisteeae*.

Introduction

Spartocytisus Webb & Berth. is a small genus endemic to the Canary Islands, which includes *S. filipes* Webb & Berth. and *S. supranubius* (L. f.) Christ ex Kunkel. This interpretation is followed by many authors who have studied the flora of the Canary Islands (Lems 1960; Lid 1967; Santos Guerra 1983; Bramwell & Bramwell 1990; Schöenfelder *et al.*, 1993). On the contrary Polhill (1976), followed by Bisby (1981), suggests to refer *Spartocytisus* to the genus *Cytisus* Desf., within the sect. *Oreosparton* (Webb) Frodin ex Polhill, where it would occupy a position closed to sect. *Trianthocytisus* Griseb. and *Alburnoides* DC., owing to several flower characters (Frodin 1965; Polhill 1976). *Spartocytisus* differs, however, from the former section in the shrubby habitus with many virgate branches, in the small, caducous leaves and in the pink or white (and not yellow) flowers grouped at the nodes of branches without leaves. It mainly differs from the species of the latter section in the terete or angled branches which are not T-shaped in cross-section and in the herbaceous and circumscissile deciduous calyx.

Spartocytisus filipes (= *Cytisus filipes* Webb & Berth.) is a small shrub of slender appearance which grows between 0 and 800 m in the clearings of sclerophyllous forest and pinewood on the Islands of Tenerife, Gomera, La Palma and Hierro. *S. supranubius* (= *Spartium supranubius* L. f., *Spartocytisus nubigenus* (Willd.) Webb & Berth.,

Cytisus supranubius (L. f.) Kuntze) is also a nanophanerophyte but of larger size and of stouter habitus. It is dominant in the vegetation of the upland and subalpine zones ("pisos supracanario y orocanario" according to Rivas Martínez 1987) of Tenerife and, more rarely, of La Palma (Lems 1960; Lid 1967; Santos Guerra 1983; Bramwell & Bramwell 1990). Its epithet derives from the fact that it grows in the zone above the clouds ("mar de nubes"), typically between 1700 and 3000 m, particularly in Las Cañadas del Teide (Is. Tenerife). The species characterizes the alliance *Spartocytisium nubigeni* Oberdorfer ex Esteve 1973 and the association *Spartocytisetum nubigeni* Oberdorfer ex Esteve 1973 (Rivas Martínez *et al.* 1993).

A karyological analysis of both species was carried out in order to increase the systematic knowledge of *Spartocytisus*. No previous karyological data were known for *S. filipes* from the literature.

Materials and methods

The karyological investigations were carried out on seeds, collected in the field, of two populations of *Spartocytisus filipes* and two populations of *S. supranubius* (Fig. 1). The localities of the collection and the names of the collectors are given in Tab. 1. Voucher specimens

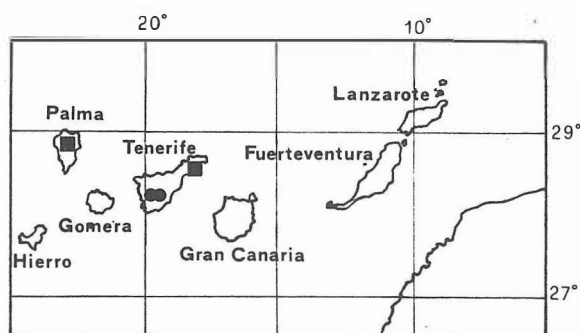


Fig. 1 - Origin of the examined populations of *Spartocytisus filipes* (■) and *S. supranubius* (●).

are deposited in the herbarium of the Department of Biology, University of Trieste (TSB).

The mitotic investigation was carried out on root tips of seedlings, pretreated with 8-hydroxyquinoline, fixed in a 1:3 solution of glacial acetic acid: absolute ethanol (Carnoy's fluid), hydrolized in HCl 1N at 60° C for six minutes and stained with Feulgen method. Slides were prepared using the squash technique. For each population 15 to 30 good metaphase plates were examined. Only numbers of chromosomes can be given here, being the somatic chromosomes too small (0.56-1.45 µm) for effective karyotyping.

Results

Spartocytisus filipes shows a high percentage of germination in both populations. The chromosome number $2n = 48$ was counted (Tab. 1). The dimensions of the chromosomes fall within an interval of 0.60 and 1.26 µm. No significant

variation in size was noted and the chromosome complement appears to be very homogeneous (Fig. 2). The chromosomes are elliptical in shape (after Persson 1971).

Spartocytisus supranubius shows, in both populations, a higher percentage of germination at a lower optimal temperature, probably related to the different ecology (higher altitude) of the plant. The chromosome number $2n = 48 + (0-4B)$ was counted (Tab. 1). The presence and number of accessory chromosomes was variable ($2n = 48$ in 31.5%, $2n = 48 + 2B$ in 57.4% and $2n = 48 + 4B$ in 11.4% of the cases examined). Borgen (1969) counted $2n = c. 48$ in material from Fortalez las Cañadas. The chromosome size ranges between 0.56 and 1.45 µm. Also in this case the complement is homogeneous and the chromosomes are too small to carry out a more thorough examination of the morphology (Fig. 2). The chromosomes are elliptical in shape (after Persson 1971).

Discussion

The karyological analysis showed that both species of the genus *Spartocytisus* have the same somatic number $2n = 48$. *S. supranubius* has a number of accessory chromosomes which varies from 0 to 4 with a maximum frequency of 2. The chromosome lengths of the two species are comparable.

In order to evaluate the karyological condition of *Spartocytisus*, a comparison was made of the known karyological data for the various taxa of the *Cytisus*-group and of the intermediate genera of the *Genisteae* with more primitive characters. The chromosome numbers recorded in the various taxa

Tab. 1 - Geographical origin of the examined populations of *Spartocytisus* species, with collectors of the seeds, chromosome numbers, number of metaphase plates studied, temperature and percentage of germination.

TAXON	LOCALITY	COLLECTOR	DIPLOID No.	No. OF PLATES	GERMINATION TEMPERATURE	% OF GERMINATION
S. filipes	Caldera de Taburiente, Is. La Palma	P. Romero Manrique	48	20	20/21 °C	70
	Valle Guerra, Is. Tenerife	A. Santos Guerra	48	15	20/21 °C	65
S. nubigenus	M. Bermeja, Is. Tenerife	A. Santos Guerra	48 + (0-4B)	30	17/18 °C	85
	Las Cañadas del Teide, Is. Tenerife	G. Junio	48 + (0-4B)	30	17/18 °C	90

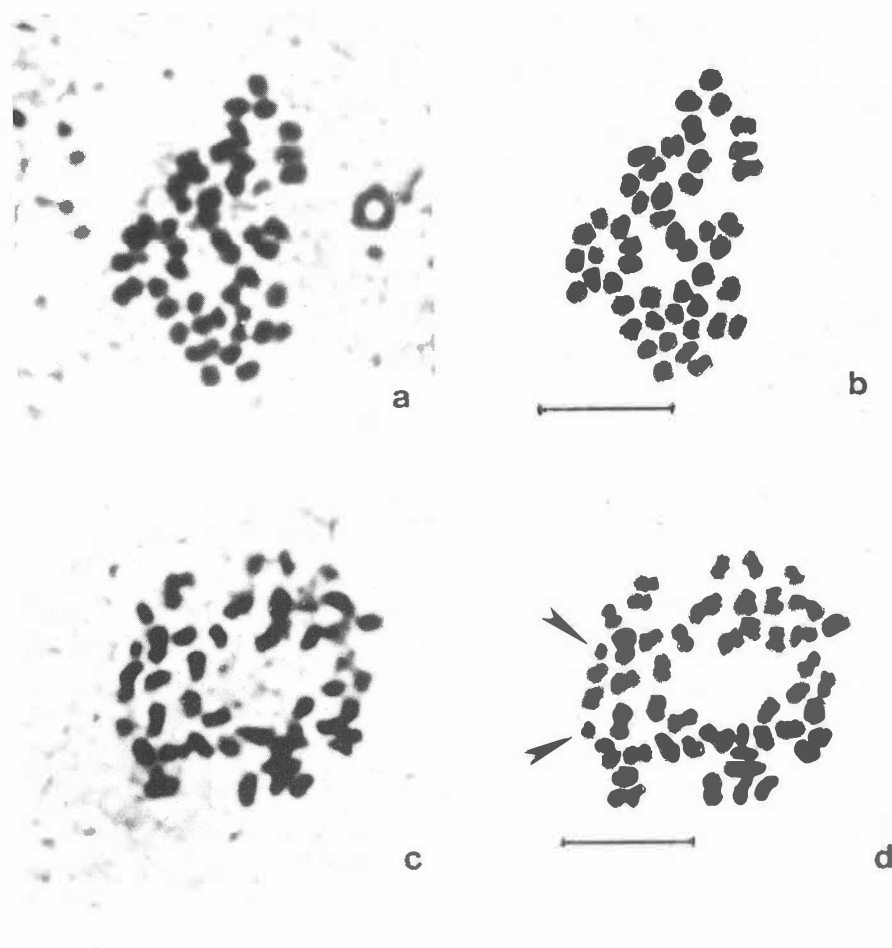


Fig. 2 - Somatic metaphase plates. - a, b, photo and drawing of *Spartocytisus filipes* ($2n = 48$); c, d, photo and drawing of *S. supranubius* ($2n = 48+2B$). B-chromosomes are arrowed. Scale bar = $5\mu\text{m}$.

of all the sections of *Cytisus* s.l., including *Chamaecytisus* Link, *Chronanthus* (DC.) C. Koch, *Lembotropis* Griseb., *Corothismus* (Koch) C. Presl and *Sarothamnus* Wimm., are shown in Tab. 2. The nomenclature of sections follows Polhill (1976), that of species follows Greuter *et al.* (1989) with the exception of the species of the sect. *Tubocytisus* DC., which is in accordance with Cristofolini (1991). The attribution of the species to the sections of *Cytisus* is taken from Frodin & Heywood (1968). *C. ingramii* was kept separate from *C. commutatus* and *C. patens* from *C. striatus*, as in Frodin & Heywood (1968), whereas Horjales (1978) and Greuter *et al.* (1989) consider these taxa, whose taxonomic status is still not entirely clear, to be synonymous.

The chromosome number $2n = 48$ is, therefore, by far the most common in the various sections of *Cytisus* s.l., even if sometimes $2n = 24, 46, 50, 96$,

100 and, more rarely, 22, 44, 52 and 54 were counted. These were interpreted as cases of hypoaneuploidy and hyperaneuploidy by Sañudo (1979) and Verlaque (1988). It can be assumed that the most probable basic chromosome number would be, both for *Spartocytisus* and for the other taxa included in *Cytisus*-group, $x = 12$ (Sañudo 1979) or perhaps $x = 6$, as proposed by Verlaque (1988). In particular, among the different sections of *Cytisus*, sect. *Corothismus*, *Spartopsis* and *Lembotropis* show chromosome numbers which can be interpreted as examples of hypoaneuploidy, whereas sect. *Trianthocytisus* and *Chronanthus* can be considered as cases of hyperaneuploidy. Sect. *Alburnoides* shows, in addition to more frequent cases of hypoaneuploidy, rarer cases of hyperaneuploidy. Sect. *Tubocytisus* is, on the other hand, more heterogeneous, with two (rarely three) ploidy levels clearly represented, frequent cases of

Tab. 2 - Chromosome numbers of the species of *Cytisus* s.l. with the bibliographic references and the origin of the seeds [the abbreviations of the territories follow Flora Europaea, except for Slovenija (SI), Hrvatska (Hr), Česká Republika (CR) and Slovenská Republika (SR)]. When horticultural material was used, the conventional acronym according to the Index Herbariorum is reported when possible; otherwise the Botanical Garden is indicated.

TAXON	APLOID No.	DIPLOID No.	REFERENCES	LOCALITY
sect. <i>Trianthocytisus</i> Griseb.				
<i>C. aeolicus</i> Lindley		2n= 48 2n= 52	Fralum-Leliveld 1957 Bartolo et al. 1977	Bot. Gard., Antibes Vulcano, Isola Eolie (It)
<i>C. villosus</i> Pourret	n= 25	2n= 48	Forissier 1975b Sañudo 1973b	Bosco di Ficuzza (It) Los Barrios, Cadiz (Hs)
<i>C. emeriflorus</i> Reichenb.	n= 25		Favarger 1969 Forissier 1973a	Grigna Meridionale (It) Grigna Meridionale (It)
sect. <i>Alburnoides</i> DC.				
<i>C. balansae</i> (Boiss.) Ball subsp. <i>europaeus</i> (G. López & Jarvis) Muñoz Garmendia (= <i>C. purgans</i> sensu Tutin & al.)	n= 23	2n= ± 46	Sañudo 1973b Forissier 1975b Castro 1949	Somosierra, Madrid (Hs) Cévennes & Lautaret (Ga) COI
<i>C. multiflorus</i> (L'Hér.) Sweet	n= 23	2n= 46 2n= 48 2n= 54 2n= ± 96	Sañudo 1973b Forissier 1975b Gilot 1965 Fernandes & Santos 1971 Fernandes et al. 1977 Fernandes & Queiros 1978 Horjales 1974 Castro 1949	Avila (Hs) Coimbra (Lu) COI Penedones (Lu) Ternas de Caldeas (Lu) Coimbra (Lu) Vila Franca, Coimbra (Lu) L
<i>C. ardoinei</i> E. Fourn.	n= 25		Forissier 1975b	Plateau de Caussols, Alpes Maritimes (Ga)
sect. <i>Coroethamnus</i> (Koch) Nyman (= <i>Coroethamnus</i> (Koch) C. Presl)				
<i>C. procumbens</i> (Willd.) Sprengel		2n= 22 2n= 44 2n= 48	Castro 1949 Hindáková 1974 Dvorák & Dadáková 1976b Dvorák 1977	E Juhoslovensky kras; Tripeniazky above Jelsava (SR) (SR) Boleradice, Kurdejov (CR) Boleradice, Kurdejov (CR)
<i>C. decumbens</i> (Durande) Spach	n= 23	2n= 48	Forissier 1973a Sañudo 1973b	W Oncala, Soria (Hs)
sect. <i>Spartopsis</i> Dumort. (= <i>Sarothamnus</i> Wimm., <i>Cytisus</i> sect. <i>Sarothamnus</i> (Wimm.) Benth.)				
<i>C. ingramii</i> Blakelock		2n= c. 92 2n= 96	Horjales 1978 Sañudo 1973b	Mañón-Coruña (Hs) Lugo (Hs)
<i>C. commutatus</i> (Willk.) Briq.	n= 23-24 n= 48		Sañudo in Lainz et al. 1976 Sañudo 1973b	Santander (Hs) Mañaria, Vizcaya (Hs)
<i>C. arboreus</i> (Desf.) DC. subsp. <i>baeticus</i> (Webb) Maire	n= 24		Sañudo 1973b	Cádiz (Hs)
subsp. <i>malacitanus</i> (Boiss.) Malagarriga	n= 24		Sañudo 1973b	Orgiva, Granada (Hs)
<i>C. striatus</i> (Hill) Rothm.	n= 23	2n= 46 2n= 46, 48 2n= 48	Forissier 1975a Sañudo 1973b Horjales 1975 Horjales 1974 Horjales 1975 Fernandes & Santos 1971 Fernandes et al. 1977	Coimbra (Lu) Lugo (Hs) Isla de Ons, Pontevedra (Hs) Coimbra (Lu) La Barquera, Coruña (Hs) San Pedro da Cova, Gondomar (Lu) Guarda, Braga (Lu)
<i>C. grandiflorus</i> (Brot.) DC.	n= 24	2n= 24 2n= 46 2n= 48	Sañudo 1973b Fernandes & Santos 1971 Gilot 1965 Horjales 1975 Fernandes et al. 1977 Fernandes & Queiros 1978	Santa Elena, Jaén (Hs) Coimbra (Lu) COI, Chelsea Physic Gard. S. Paulo de Frades, Coimbra (Lu) Caldeas, Vila Nova de Gaia (Lu) Guarda (Lu)
<i>C. scoparius</i> (L.) Link	n= 23	2n= 24 2n= 46 2n= 46, 48 2n= 48	Forissier 1973a Sañudo 1973b Berger et al. 1958 (after Sañudo 1979) Gilot 1965 Gill & Walker 1971 Zielinski 1975 Horjales 1975 Heiser & Winker 1948 Morton 1955 Böcher & Larsen 1955 Horjales 1975 Fernandes et al. 1977 Fernandes & Queiros 1978	Corrêze (Ga) Santa Elena, Jaén (Hs) G, Bot. Gard. Delft various localities (Br) Blaziejewka (Po) Sigueiro, Trasmonte-Sedeira, Coruña (Hs) California (introduced) Longtown, Cumberland (Br) various localities (Ge, Ho, Br, Ga, Hs) La Barquera, Coruña (Hs) Penedones (Lu) Minho (Lu)

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subsp. <i>maritimus</i> (Rouy) Heywood		2n= 24 2n= 46 2n= 48	Morton 1955 Gill & Walker 1971 Böcher & Larsen 1955 Adams 1957 Gill & Walker 1971	Lizard, Cornwall (Br) Dungeness (Br) Grosnez Point, Jersey (Br) Lizard Head, Cornwall (Br) Cornwall (Br)
subsp. <i>cantabricus</i> (Willk.) Rivas Martinez & al.	n= 24		Sañudo 1973b	Santander (Hs)
subsp. <i>reverchonii</i> (Degen & Hervier) Rivas Goday & Rivas Martinez	n= 24	2n= ± 46	Sañudo 1973b Castro 1949	Alcaraz, Teruel (Hs) E
<i>C. patens</i> L.	n= 24	2n= ± 46	Sañudo 1973b Castro 1949	Valencia (Hs) YALT
<i>C. tribracteolatus</i> Webb	n= 24		Sañudo 1973b	Cádiz (Hs)
sect. <i>Chronanthus</i> DC. (= <i>Chronanthus</i> (DC.) C. Koch)				
<i>C. fontanesii</i> Ball (= <i>Chronanthus biflorus</i> (Desf.) Frodin & Heywood)	n= 25	2n= 24	Sañudo 1973a Castro 1949	Zaragoza (Hs); El Fargue, Puerto Lope, Sierra de Lújar, Granada (Hs) E
sect. <i>Lembotropis</i> (Griseb.) Benth. (= <i>Lembotropis</i> Griseb.)				
<i>C. nigricans</i> L. (= <i>Lembotropis nigricans</i> (L.) Griseb)	n= 23	2n= 48 2n= 96	Forissier 1973a Santos 1944-45 Hindáková & Cincura 1967 Nilsson & Lassen 1971 Kozuharov et al. 1972 Zielinski 1975 Castro 1949	Karpaty (SR), Südlicher Wienerwald (Au) SBT Cernochov (SR) Novi Vinodolski (Hr) Hubávec, Karlovo (Bu) Przedborza (Po) POZ
sect. <i>Tubocytisus</i> DC. (= <i>Chamaecytisus</i> Link)				
<i>C. proliferus</i> L. fil.		2n= 46,50 2n= 48	Horjales 1975 Castro 1949 Borgen 1969	ORT Bot. Gard., Orotava GB
var. <i>angustifolius</i> O. Kuntze		2n= 52	Horjales 1975	ORT
<i>C. spinescens</i> C. Presl	n= 50		Forissier 1973b	Ovindoli (It)
<i>C. purpureus</i> Scop.	n= 25	2n= 48	Forissier 1973b Strasburger 1905 Gilot 1965	Monte Baldo (It) Bot. Gard., Oldenburg
<i>C. hirsutus</i> L. (= <i>C. aggregatus</i> Schur, <i>C. ciliatus</i> Wahlenb., <i>C. capitatus</i> Scop., <i>C. supinus</i> L., <i>C. leucotrichus</i> Schur)	n= 25 n= 50	2n= ± 46 2n= 48 2n= 50 2n= c. 84 2n= c. 91 2n= 96	Forissier 1973a Forissier 1973b Forissier 1973a Castro 1949 Nilsson & Lassen 1971 Zielinski 1975 Kuzmanov & Markova 197 Horjales 1975 Horjales 1975 Gilot 1965 Kuzmanov et al. 1973 Kuzmanov & Markova 197	Muntele Suhardul (Rm) Timpa (Rm), Graz (Au) Col di Tenda, Lago di Garda (It) BAS Pivka (Slo) Sobótka (Po) by the river Danube (Bu) BIRM DUIS HAL, DR, MOD Ruse (Bu) Belogradcik (Bu)
<i>C. hirsutus</i> L. subsp. <i>polytrichus</i> (M. Bieb.) Hayek	n= 25	2n= 46	Forissier 1975a Strid & Andersson 1985	Certosa di Pesio (It); Pazin (Hr) M. Olympus (Gr)
<i>C. leiocarpus</i> A. Kemer	n= 25	2n= ± 48	Forissier 1973b Castro 1949	"Romania" E
<i>C. triflorus</i> Lam. (= <i>C. elongatus</i> Waldst. & Kit.)		2n= 48	Frahn-Lehfeld 1957	Z
<i>C. gallicus</i> A. Kemer (sub " <i>Chamaecytisus</i> <i>supinus</i> (L.) Link subsp. <i>capitatus</i> (Scop.)")	n= 50		Forissier 1973a	Quémigny (Ga)
<i>C. lasiosemius</i> Boiss. (= <i>C. frivaldszkyanus</i> Degen)		2n= 48	Kuzmanov 1975	M. Rhodope (Bu)
<i>C. eriocarpus</i> Boiss. subsp. <i>eriocarpus</i> (= <i>C. absinthioides</i> Janka)		2n= 96	Kozuharov et al. 1972	Sestrimo, Rila (Bu)
<i>C. austriacus</i> L. subsp. <i>austriacus</i>	n= 50	2n= 48 2n= 96	Forissier 1973a Dvorák & Dadákova 1976a Dvorák 1977 Castro 1949	Hainburg Donau (Au) Mutenice, Ceje (CR) K. Bot. Gard. Tabor, Bot. Gard. Moorestown
<i>C. austriacus</i> L. subsp. <i>austriacus</i> var. <i>rochelii</i> (Wierzb.) Cristof.		2n= 48 2n= 96	Gilot 1965 Hindáková & Cincura 1967 Castro 1949	STA, POZ Cernochov (SR) LISU
<i>C. albus</i> Hacq.		2n= 48 2n= 50	Zielinski 1975 Forissier 1973a Kuzmanov et al. 1973	Bugiem (Po) Karpaty (SR) Tamovo (Bu)
<i>C. ratisbonensis</i> Schaeffer		2n= 24, 48 2n= 48	Zielinski 1975 Dvorák & Dadákova 1976a Dvorák 1977	Przedbórz, Maslowice, Olkusz (Po) Boleradice, Kurdejov (CR)
<i>C. ruthenicus</i> Fischer ex Woloszak (= <i>C. caucasicus</i> Grossh.) subsp. <i>ruthenicus</i>	n= 25 n= 50	2n= 48 2n= 50	Forissier 1973a Forissier 1973a Zielinski 1975 Castro 1949	Bot. Gard., Tiflis (Georgia) Riazan, Moskow (Rs) various localities (Po) VOR
Incertae sedis				
<i>C. procerus</i> Link	n= 23		Sañudo 1973b	Avila (Hs)

hyperaneuploidy and sporadic examples of hypoaneuploidy. It is possible, however, that the counting of $2n = 50, 52, 54, 100$ was, at least in some cases, due to the presence of accessory chromosomes, as found in *S. supranubius* (Tab. 1). Furthermore, conflicting chromosome counts could also be due to the presence in the complement of very small and satellited chromosomes, in which the connection between the satellites and the remainder of the chromosome is frequently very tenuous, so that mistaken counts are easily obtained (Gill & Walker 1971).

Intermediate genera of the *Genisteae* with more primitive characters (Polhill 1976, 1979; Cristofolini & Feoli Chiapella 1984), such as *Cytisophyllum* Lang, *Argyrocytissus* (Maire) Raynaud, *Petteria* C. Presl, *Laburnum* Fabr., have only occasionally chromosome number $2n = 48$, whereas different numbers such as $2n = 50$ and $2n = 52$ were counted more often (Tschechow 1931; Castro 1949; Gilot 1965; Forissier 1973b; Sañudo 1973b; Fernandes & Queirós 1978; Verlaque *et al.* 1987). According to Verlaque (1988), this would reveal, in relict genera with a single polyploid level, the presence of a senescent phase in the aneuploid evolution, characterized by stabilized aneuploidy. On the contrary, *Cytissus* s.l. has three levels of ploidy, still showing characters of expansion or at least of decline. In particular *Chamaecytissus* seems to be, also on the basis of karyological characters, still in an active phase of speciation.

The fact that *Spartocytissus* presents an eupolyploid complement, even though the presence of accessory chromosomes, suggests to consider it as belonging to the *Cytissus*-group rather than being a relict, systematically more isolated genus. *S. filipes* and *S. supranubius* would therefore constitute a young, karyologically and morphologically homogeneous genus, evolved in the Canary Islands.

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References

Adams F.W., 1957. *Chromosome numbers of Sarothamnus scoparius* (L.) Wimmer. *Watsonia*, 4 (1): 17-18.

- Bartolo G., Brullo S., Majorana G. & Pavone P., 1977. *Numeri Cromosomici per la Flora Italiana: 315-328*. *Inform. Bot. Ital.*, 9 (1): 71-87.
- Berger C.A., Witkus E.R. & Mc Mahon R.M., 1958. *Cytotaxonomic studies in the Leguminosae*. *Bull. Torrey Bot. Club*, 85 (6): 405-414.
- Bisby F.A., 1981. *Genisteae (Adans.) Benth.* In: Polhill R.M. & Raven P.H. (eds.), *Advances in Legume Systematics*. 1. Royal Bot. Gardens, Kew, 409-425.
- Böcher T.W. & Larsen K., 1955. *Chromosomes studies on some European flowering plants*. *Bot. Tidsskr.*, 52 (2): 125-132.
- Borgen L., 1969. *Chromosome numbers of vascular plants from the Canary Islands, with special reference to the occurrence of polyploidy*. *Nytt Mag. Bot.*, 16: 81-121.
- Bramwell D. & Bramwell Z.I., 1990. *Flores Silvestres de las Islas Canarias*. Rueda, Madrid, 376 + XIV pp.
- Castro D. de, 1949. *Novas números de cromosomas para o género Cytissus L.* *Agron. Lusit.*, 11 (2): 85-89.
- Cristofolini G., 1991. *Taxonomic revision of Cytissus Desf. sect. Tubocytissus DC. (Fabaceae)*. *Webbia*, 45 (2): 187-219.
- Cristofolini G. & Feoli Chiapella L., 1984. *Origin and diversification of Genisteae (Fabaceae): a serosystematic purview*. *Webbia*, 38: 105-122.
- Dvorák F., 1977. *Study of chromosomes of Angiosperms 5*. *Scripta Fac. Sci. Nat. Ujcp. Brun. Biol.*, 1 (7): 9-30.
- Dvorák F. & Dadáková B., 1976. In: Löve A. (ed.), *IOPB chromosome number reports LIII*. *Taxon*, 25 (4): 483-500.
- Favarger C., 1969. In: Löve A. (ed.), *IOPB chromosome number reports XXII*. *Taxon*, 18: 433-442.
- Fernandes A. & Queirós M., 1978. *Contribution à la connaissance cytotoxinomique des Spermatophyta du Portugal. IV. Leguminosae (Suppl. 3)*. *Bol. Soc. Brot.*, 52: 79-164.
- Fernandes A. & Santos M.F., 1971. *Contribution à la connaissance cytotoxinomique des Spermatophyta du Portugal. IV. Leguminosae*. *Bol. Soc. Brot.*, 45: 177-226.
- Fernandes A., Santos M.F. & Queirós M., 1977. *Contribution à la connaissance cytotoxinomique des Spermatophyta du Portugal. IV. Leguminosae (Suppl. 2)*. *Bol. Soc. Brot.*, 51: 137-186.
- Forissier R., 1973a. *Recherches cytotoxinomiques préliminaires sur les genres Lembotropis, Cytissus, Chamaecytissus, Genista et Chamaespartium*. *Bull. Soc. Neuchâteloise Sci. Nat.*, 96: 51-65.
- Forissier R., 1973b. In: Löve A. (ed.), *IOPB chromosome number reports XLII*. *Taxon*, 22 (5/6): 647-654.
- Forissier R., 1975a. In: Löve A. (ed.), *IOPB chromosome number reports XLVII*. *Taxon*, 24 (1): 143-146.
- Forissier R., 1975b. In: Löve A. (ed.), *IOPB chromosome number reports L*. *Taxon*, 24 (5/6): 671-678.
- Frahm-Leliveld J.A., 1957. *Observations cytologiques sur quelques Légumineuses tropicales et subtropicales*. *Rev. Cytol. Biol. Vég.*, 18 (3): 273-287.
- Frodin J., 1965. *Generic and sectional limits in Cytissus L. s. lat.* M. Sc. Thesis, University of Liverpool.
- Frodin D.G. & Heywood V.H., 1968. *Cytissus L.* In: Tutin T.G., Heywood V.H., Burges N.A., Moore D.M., Valentine D.H., Walters S.M. & Webb D.A. (eds.), *Flora Europaea*. 2. Cambridge University Press, Cambridge, 86-90.
- Gill J.J.B. & Walker S., 1971. *Studies on Cytissus scoparius (L.) Link with particular reference to the prostrate forms*. *Watsonia*, 8: 345-356.

- Gilot J., 1965. *Contribution à l'étude cytotaxonomique des Genisteae et des Loteae*. Cellule, 65 (3): 317-347.
- Greuter W., Burdet H.M. & Long G. (eds.), 1989. *Med-checklist*. 4. Conservatoire et Jardin botaniques, Genève, 458 + CXXIX pp.
- Heiser C.B. & Whitaker T.W., 1948. *Chromosome number, polyploidy, and growth habit in California weeds*. Amer. J. Bot., 35 (3): 179-186.
- Hindáková M., 1974. In: Májovsky J. et al. (eds.), *Index of chromosome numbers of Slovakian Flora (Part 3)*. Acta Fac. Rerum Nat. Univ. Comenianae Bot., 22: 1-20.
- Hindáková M. & Cincura F., 1967. *Angaben über die Zahl und Morphologie der Chromosomen einiger Pflanzenarten aus dem Territorium der Ostslowakei I*. Acta Fac. Rerum Nat. Univ. Comenianae Bot., 14: 181-227.
- Horjales M., 1974. *Números cromosómicos en Genisteas*. Anales Inst. Bot. Cavanilles, 31: 175-178.
- Horjales M., 1975. *Números cromosómicos en Genisteas, II*. Trab. Dep. Bot. (Madrid), 7: 43-50.
- Horjales M., 1978. *Sobre el status taxonómico de Cytisus ingramii Blakelock*. Bol. Soc. Brot., 52: 295-306.
- Kozuharov S.I., Kuzmanov B.A. & Markova T., 1972. In: Löve A. (ed.), *IOPB chromosome number reports XXXVI*. Taxon, 21 (2/3): 333-346.
- Kuzmanov B.A., 1975. In: Löve A. (ed.), *IOPB chromosome number reports XLIX*. Taxon, 24 (4): 501-516.
- Kuzmanov B.A. & Markova T., 1973. In: Löve A. (ed.), *IOPB chromosome number reports XL*. Taxon, 22 (2/3): 285-291.
- Kuzmanov B.A., Ancey M.E. & Markova T.A., 1973. In: Löve A. (ed.), *IOPB chromosome number reports XLI*. Taxon, 22 (4): 459-464.
- Lainz M., 1976. *Aportaciones al conocimiento de la Flora Cántabro-asturiana, XI*. Bol. Inst. Estud. Asturianos (Supl. Cien.), 22: 3-44.
- Lems K., 1960. *Floristic Botany of the Canary Islands*. Sarracenia, 5: 1-94.
- Lid J., 1967. *Contributions to the Flora of the Canary Islands*. Norske Vidensk. - Akad., Mat. - Naturvidensk. Kl., Avh., 23: 3-212.
- Morton J.K., 1955. *Chromosome studies on Sarothamnus scoparius (L.) Wimmer and its subspecies prostratus (Bailey) Tutin*. New Phytol., 54 (1): 68-69.
- Nilsson Ö & Lassen P., 1971. *Chromosome numbers of vascular plants from Austria, Mallorca and Yugoslavia*. Bot. Not., 124: 270-276.
- Persson J., 1971. *Studies in the Aegean Flora. XIX. Notes on Alyssum and some others genera of Cruciferae*. Bot. Not., 124: 399-418.
- Polhill R.M., 1976. *Genisteae (Adans.) Benth. and related tribes (Leguminosae)*. Bot. Syst., 1: 143-368.
- Polhill R.M., 1979. *Proposal to conserve and retype the name Cytisus (Leguminosae)*. Taxon 27: 556-559.
- Rivas-Martínez S., 1987. *Nociones sobre fitosociología, biogeografía y bioclimatología*. In: Peinado Lorca M. & Rivas-Martínez S. (eds.), *La Vegetation de España*. Universidad de Alcalá de Henares, 17-45.
- Rivas-Martínez S., Wildpret de la Torre W., del Arco Aguilar M., Rodríguez O., Pérez de Paz P.L., García-Gallo A., Acebes Ginovés R., Díaz González T.E. & Fernández-González F., 1993. *Las comunidades vegetales de la Isla de Tenerife (Islas Canarias)*. Itin. Geobot., 7: 169-374. Santos A.C. dos, 1944-45. *Algumas contagens de cromosomas nos géneros Genista L. e Cytisus L.* Bol. Soc. Brot., 19: 519-522.
- Santos Guerra A., 1983. *Vegetation y Flora de la Palma*. Editorial Interinsular Canaria, Santa Cruz de Tenerife, 348 pp.
- Sañudo A., 1973a. *Variabilidad cromosómica de las Genisteas de la Flora española en relación con su ecología. I. Número y comportamiento de los cromosomas durante la meiosis. D. Géneros Chronanthus (DC.) C. Koch, Adenocarpus DC. y Erinacea Adanson*. Lagasalia, 3 (2): 205-210.
- Sañudo A., 1973b. *Variabilidad cromosómica de las Genisteas de la Flora española en relación con su ecología. I. Número y comportamiento de los cromosomas durante la meiosis. E. Género Cytisus L.* Bol. Soc. Esp. Hist. Nat., 71: 341-355.
- Sañudo A., 1979. *Chromosome variability in the Genisteae (Adans.) Benth. (Leguminosae)*. Webbia, 34 (1): 363-408.
- Schönfelder P., León Arencibia M.C. & Wildpret de la Torre W., 1993. *Catálogo de la Flora vascular de la Isla de Tenerife*. Itin. Geobot., 7: 375-404.
- Strasburger E., 1905. *Typische und allotypische Kernteilung*. Jahrb. Wissen. Bot., 42 (1): 1-71.
- Strasburger E., 1907. *Über die Individualität der Chromosomen und die Pfropfhybriden-Frage*. Jahrb. Wissen. Bot., 44 (3): 482-555.
- Strid A. & Andersson I.A., 1985. *Chromosome numbers of Greek mountain plants. An annotated list of 115 species*. Bot. Jahrb. Syst., 107 (1-4): 203-228.
- Tschechow W., 1931. *Karyologisch - systematische Untersuchung der Tribus Sophoreae, Podalyrieae und Genisteae*. Izv. Tomsk. Otd. Gosud. Russk. Bot. Obsc., 3 (1/2): 121-131.
- Verlaque R., 1988. *Modalités de la speciation chez les Genisteae*. Act. Simp. Int. Bot. Pius Font i Quer, 2: 49-68.
- Verlaque R., Seidenbinden M. & Reynaud C., 1987. *Recherches cytotaxonomiques sur la speciation en région Méditerranéenne III: espèces aneuploides*. Rev. Biol. - Ecol. médit., 10: 315-346.
- Zielinski J., 1975. *The genus Cytisus L. s.l. in Poland*. Arbor. Kórnickie, 20: 47-111.

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CONTRIBUTION TO THE SYSTEMATICS OF *GENISTA* L. SECT. *SPARTOCARPUS* SPACH (*GENISTEAE*, *FABACEAE*) WITH EMPHASIS ON PALYNOLOGICAL DATA

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Keywords: *Fabaceae*, *Genista*, *Genisteae*, Multivariate analysis, Pollen, *Spartocarpus*, Systematics.

Abstract: A pollen analysis of *Genista* sect. *Spartocarpus* has been carried out on 124 samples from 15 species. The taxa were compared in terms of quantitative and qualitative pollen characters, analysed by LM and SEM. Multivariate analysis subdivides taxa into four clusters. *Genista radiata*, *G. holopetala* and *G. hassertiana*, E-Alpine-Balkan species with capitate inflorescence, form an isolate cluster that is palynologically, morphologically and karyologically homogeneous. The other species, with inflorescences of racemous type, can be grouped in three clusters: the first comprising *G. sessilifolia*, *G. nissana* and *G. aucheri*, Balkan-Anatolian taxa, the second including *G. spartioides*, *G. haenseleri* and *G. numidica*, Spanish and N-African species, the third comprising the W-Mediterranean *G. ephedroides*, *G. thyrrana*, *G. gasparrinii*, *G. cilentina*, *G. aetnensis* and *G. dorycnifolia*. Pollen characters and morphological, karyological and biogeographical data appear to be related. The arrangement proposed by Gibbs (1966), who has grouped all the examined species in sect. *Spartocarpus*, is supported by the pollen analysis. On the basis of pollen characters all taxa of *Genista* sect. *Spartocarpus* may be considered as well distinguished. The specific treatment of these taxa in Greuter *et al.* (1989) is, in general terms, confirmed by palynological data. However, the grouping of *G. radiata*, *G. holopetala* and *G. hassertiana* in the *G. radiata*-group and of *G. ephedroides*, *G. gasparrinii*, *G. thyrrana* and *G. cilentina* in the *G. ephedroides*-group is proposed.

Introduction

The tribe *Genisteae* (*Fabaceae*) includes about twenty genera mainly distributed in the Mediterranean region. The delimitation of *Genisteae* has long been a matter of debate: in particular the systematics of *Genista* L. is still controversial. The genus delimitation is likewise uncertain. Not all authorities agree on segregating *Cytisanthus* O. F. Lang, *Chamaespartium* Adanson (= *Genistella* Ortega), *Teline* Medicus and *Echinospartum* (Spach) Rothm. from *Genista*.

Several studies on the morphology (Gibbs 1966; Polhill 1976; Bisby 1981), anatomy (Pellegrin 1908), morphometry (Bisby & Nicholls 1977), cytotaxonomy (Sañudo 1979; Cusma Velari & Feoli Chiapella 1987a, b, 1991), serology (Cristofolini & Feoli Chiapella 1977, 1984), chemotaxonomy (Harborne 1969; Faugerat & Paris 1971) and pollination biology of the tribe (Polhill 1976; Bisby 1981) have been carried out.

Many studies concern pollen morphology. The pollen grains of *Genisteae* show a relatively uniform morphology: single medium-sized

radiosymmetric, isopolar, tricolpate or tricolporoidate grains, with perforate tectum and pitted supracolpate exine (Polhill 1976; Ferguson & Skvarla 1981; Misset *et al.* 1982; Rizzi Longo & Feoli Chiapella 1981a, 1993; Feoli Chiapella 1983; Cubas & Pardo 1984). In *Fabaceae*, where the commonest situation is the presence of colpi, the trend towards colpi is considered by Guinet (1981) as a trend to specialisation. According to Walker & Doyle (1975) and Guinet (1981) the tricolpate aperture, in *Genisteae* as well as in other tribes, might be the result of a secondary reduction of the *ora* from tricolporate ancestors: this is interpreted as an apparent reversal of the evolutionary trend from tricolpate to tricolporate apertures, due, according to Guinet (1981), to the structure of the exine layers: the marked reduction of endexine would cause the disappearance of the endoaperture (*os*).

Being *Genisteae* a stenopollinic tribe, the identification of its pollen on the basis of qualitative characters is possible only in a few

cases; for this reason biometric analyses were often undertaken in order to try to distinguish the taxa also on the basis of quantitative characters. A detailed study of pollen characters, by light and scanning electron microscope, was started on the genus *Genista*, the most heterogeneous and complex of the tribe. Pollens of some taxa of the genus *Genista*, belonging to the sect. *Spartioides* Spach (Feoli Chiapella 1982a; Rizzi Longo & Feoli Chiapella 1986, 1993; Rizzi Longo *et al.* 1986), *Voglera* (Gaertn., Mey. & Schreb.) Spach (Rizzi Longo & Feoli Chiapella 1981b; Feoli Chiapella 1983), *Acanthospartum* Spach (Rizzi Longo *et al.* 1987, 1988), and *Cephalospartum* Spach emend. P. Gibbs (Rizzi Longo *et al.* 1985; Rizzi Longo & Feoli Chiapella 1990) have been analysed. The ultrastructure of the exine of 15 species of *Genista*, chosen so as to represent all the sections of the genus, has also been examined by transmission electron microscope (Ghirardelli *et al.* 1994).

In the present study a pollen analysis of *Genista* sect. *Spartocarpus* has been carried out; preliminary results were discussed by Feoli Chiapella (1982b) and Feoli Chiapella & Rizzi Longo (1984). The analysis has been undertaken in order to contribute to the systematics of the section and to study the correlations among the different taxa.

Genista subgen. *Spartocarpus* Spach comprises about twenty species, which have been arranged by Gibbs (1966) in the following four sections: sect. *Spartocarpus*, sect. *Acanthospartum* Spach, sect. *Fasselospartum* P. Gibbs and sect. *Cephalospartum* Spach emend. P. Gibbs. The species of the subgenus *Spartocarpus* are distinguished from those of the other two subgenera of *Genista* (subgen. *Genista* and subgen. *Phyllobotrys* Spach) mainly by several characters of the corolla; other differential, but less constant, characters concern the leaves, the branching and the legume (Gibbs 1966).

The sect. *Spartocarpus* (incl. *Asterospartum* Spach, *Ephedrospartum* Spach, *Retamospartum* Spach apud Cosson) is the type section of the subgenus. It includes non-spiny shrubs with alternate, subopposite or completely opposite branching, sessile trifoliolate or, more rarely, unifoliolate leaves, with 3 vascular traces (Pellegrin 1908), broadly ovate standard, usually shorter than the keel, flowers in racemes or clusters, ovoid - acuminate 1-2 seeded legume (Gibbs 1966). Tab. 1 shows the differential characters of the species of the sect. *Spartocarpus*.

Spach (1844) placed the species known at his time and now referred to the sect. *Spartocarpus* partly in sect. *Asterospartum* and partly in sect. *Ephedrospartum*. Spach's distinction between these two sections (1844) is based on characters such as branching (opposite and alternate or fasciculate respectively), leaves (opposite, non caducous, trifoliolate and alternate, caducous trifoliolate or unifoliolate respectively) and inflorescence (terminal, subcapitate or with flowers borne opposite or subopposite in interrupted racemes and terminal racemes with alternate flowers respectively).

The inclusion of most of the species of sect. *Spartocarpus* in the genus *Cytisanthus* has been proposed (Gams 1923; Fukarek 1964; Mayer 1970) on account of the morphological characters discriminant from the other infrageneric taxa of *Genista* (opposite, decussate branches, opposite trifoliolate leaves, linear or very narrowly oblanceolate leaflets, grown together stipules). According to Cristofolini & Feoli Chiapella (1977, 1984) the examined species of sect. *Spartocarpus* clearly differ from the other species of *Genista* also serologically, showing, however, a closer affinity with *Retama* Rafin. (= *Lygos* Adanson) and various intermediate genera of Genisteae, such as *Spartium* L. and *Echinopartum*. These authors likewise propose to maintain these species in the genus *Cytisanthus*. Other authors, on the contrary (Gibbs 1966, 1968; Polhill 1976; Bisby 1981), include the species of sect. *Spartocarpus* in *Genista*.

Examined taxa

The species of sect. *Spartocarpus* prevalently occur in the Mediterranean region. Two main distribution centers can be distinguished: one in the east (Balkan Peninsula) and one in the west (southern Spain and north-western Africa), with some species mainly occurring on the Tyrrhenian islands.

Mainly eastern species are: *Genista radiata* (L.) Scop., *G. holopetala* (Koch) Bald., *G. hassertiana* (Bald.) Buchegger, *G. sessilifolia* DC., *G. nissana* Petrović, *G. aucheri* Boiss.

Genista radiata, a south-east European orophyte, occurs in the south-eastern Alps, with some disjunct stations in the western Alps (Dauphiné, Valais, Val di Sesia), on the northern and central Apennins and in the central-western Balkan Peninsula (Buchegger 1912; Bertolani Marchetti 1960; Fukarek 1964). Scattered

Tab. 1 - Main differential morphological characters among the species of the sect. *Spartocarpus*.

	<i>G. radiata</i>	<i>G. holopetala</i>	<i>G. hassertiana</i>	<i>G. sessilifolia</i>	<i>G. nissana</i>	<i>G. aucheri</i>	<i>G. spartioides</i>	<i>G. haenseleri</i>
branches	opposite	opposite	opposite	opposite and subopposite	alternate and subopposite	subopposite and alternate	alternate and fasciculate	alternate and subopposite
leaves	trifoliolate opposite subsessile caducous	trifoliolate opposite sessile persistent	trifoliolate opposite sessile persistent	trifoliolate alternate and subopposite sessile or shortly petiolate persistent	trifoliolate alternate and subopposite sessile persistent	trifoliolate subopposite and alternate shortly petiolate persistent	unifoliolate alternate and subopposite sessile fugacious	unifoliolate alternate shortly petiolate fugacious
inflorescence	flowers subopposite in terminal clusters of 3-12 pedicel c. 1 mm or lacking	flowers opposite usually 2 or 4 per branch, subterminal pedicel c. 1 mm or lacking	flowers opposite in terminal clusters of 2-4 (8), sometimes lower pair remote pedicel c. 1 mm or lacking	flowers alternate or sometimes subopposite singly in lax, many-flowered racemes pedicel 1 mm or less	flowers alternate or sometimes subopposite singly in lax, many-flowered racemes pedicel 1.5 mm	flowers opposite or subopposite singly in interrupted racemes pedicel 1.5 mm	flowers alternate or subopposite singly or in clusters in interrupted racemes pedicel 1 mm	flowers alternate in clusters of 2-4 on short lateral branches pedicel 2-3 mm

	<i>G. doryenifolia</i>	<i>G. aetnensis</i>	<i>G. numidica</i>	<i>G. ephedroides</i>	<i>G. thyrrina</i>	<i>G. gasparrinii</i>	<i>G. cilentina</i>
branches	alternate and subopposite	alternate and subfasciculate pendent	alternate and subopposite	alternate and subopposite mucronate	alternate and subopposite pendent	subopposite and fasciculate gracile	alternate and fasciculate
leaves	trifoliolate opposite and alternate subsessile persistent	unifoliolate alternate and subopposite subsessile fugacious	trifoliolate, upper unifoliolate alternate subsessile fugacious	trifoliolate, upper unifoliolate alternate or subopposite sessile fugacious	trifoliolate, upper unifoliolate alternate or subopposite sessile fugacious	trifoliolate, upper unifoliolate alternate sessile fugacious	trifoliolate, upper unifoliolate alternate sessile fugacious
inflorescence	flowers alternate or subopposite in congested terminal racemes pedicel 1-2 mm	flowers alternate and opposite in lax, terminal, many-flowered racemes pedicel 1-3 mm	flowers alternate or subopposite in terminal racemes of 5-20 (30) pedicel 1-2 mm	flowers alternate or subopposite in lax racemes of 5-10 pedicel 2-2.5 mm	flowers alternate or subopposite in dense, pendent many-flowered racemes pedicel 1.5 mm	flowers alternate or subopposite in terminal, lax or dense racemes of 5-20 pedicel 2 mm	flowers alternate in dense, many-flowered racemes pedicel 1.5-2 mm

stations can be found in northern Greece (Pindus and Olympus Mts, Strid 1986). Three varieties have been described: var. *radiata*, var. *sericopetala* Buchegger and var. *bosniaca* Buchegger; because

of lack of material it has been impossible to analyse this last variety, in any case based on a single specimen, but of which Gibbs (1966) himself could not confirm the status.

Genista holopetala (= *G. radiata* var. *nana* Spach), a species endemic to Liburnia, with fragmentary distribution, occurs in south-western Slovenia (Mt Čaven), in south-western Hrvatska (Velebit, Kapela and Obruć Mts, Buchegger 1912; Strgar 1963; Fukarek 1964), in Italy (area of Trieste, Poldini 1964; Feoli Chiapella & Rizzi Longo 1987).

Genista hassertiana (= *G. holopetala* var. *hassertiana* Bald.) occurs only in northern Albania and in southern Srbija, northern Makedonija and northern Greece (Buchegger 1912; Fukarek 1964; Strid 1986).

Genista sessilifolia (= *G. trifoliolata* Janka) in two slightly separated areas, the first one extending in Turkey, the other one in the south of the Balkan Peninsula (Bulgaria, southern Romania and Makedonija) and in northern Greece (Gibbs 1966, 1970; Greuter *et al.* 1989). Two subspecies have been distinguished: ssp. *sessilifolia*, distributed in Makedonija, Bulgaria, Turkey and Greece, and ssp. *romanica* (Prodan) P. Gibbs, which occurs in the region of Dobruja in Romania (Gibbs 1966). On the contrary, Greuter *et al.* (1989) placed only the populations of Turkey in ssp. *sessilifolia*, and referred all the European populations to ssp. *romanica*.

Genista nissana occurs in southern Srbija and northern Makedonija (Gibbs 1966; Mayer 1970).

In his reappraisal of the genus *Cytisanthus*, Mayer (1970) subdivides the east European species of sect. *Spartocarpus* in two series: series *Capitati*, with flowers in terminal clusters, and series *Racemosi*, with flowers in long, lax, many-flowered racemes. To the first one belong *Genista radiata*, *G. holopetala* and *G. hassertiana*, to the second *G. sessilifolia* and *G. nissana*.

Genista aucheri, an Anatolian endemic (Gibbs 1966, 1970), is distinguished from the others mainly by flowers borne singly opposite or subopposite in interrupted racemes.

The western species are: *Genista spartioides* Spach (= *G. retamoides* Cosson), *G. haenseleri* Boiss., *G. aetnensis* (Biv.) DC., *G. dorycnifolia* Font Quer, and *G. ephedroides* complex.

Genista spartioides occurs in the southern and south-eastern regions of Spain and in northern Algeria and Morocco (Willkomm 1880; Quezel & Santa 1962; Maire 1987).

Genista haenseleri is endemic to a very small area in the south of Spain, near Malaga (Willkomm 1880; Gibbs 1966).

Genista spartioides and *G. haenseleri* are

distinguished from most of the other species of sect. *Spartocarpus* by their unifoliolate, alternate or subopposite leaves and by their flowers, in racemes of clusters (rarely in racemes). *G. haenseleri* was placed by Spach (1845) among the "species excludendae" from *Genista*; he proposed its inclusion in *Cytisus* or the creation of a new genus. Later the species was included by Willkomm (1880) in *Genista* sect. *Erinacoides* Spach (subgenus *Genista*), from which, however, it is distinguished by several anatomical characters (Pellegrin 1908); Gibbs (1966) on the contrary placed it in sect. *Spartocarpus*.

Genista aetnensis occurs in natural habitats only in Sardinia and on the Etna Volcano in Sicily (Fiori 1925), while its occurrence in natural habitats in Corse has been doubted (Greuter *et al.* 1989). Spach (1845) excluded also this species from *Genista*, and devised for it a different classification, creating the genus *Dendrospartum* Spach.

Genista dorycnifolia is endemic to few areas of Ibiza, Islas Baleares (Knoche 1922; Gibbs 1966). Because of its inflorescence (congested racemes) it has an intermediate position between *G. aetnensis* and *G. ephedroides* (usually lax racemes) and *G. radiata* and allied species (terminal clusters).

The *Genista ephedroides* complex is subject to divergent views. While Gibbs (1966) placed all the taxa mentioned by Spach (1844) - *G. numidica* Spach, *G. ephedroides* DC., *G. gasparrinii* (Guss.) C. Presl - in *G. ephedroides*, more recently Valsecchi (1986b), even though admitting the close affinity among the three taxa, kept them as separate. Furthermore, Valsecchi (1986a) described a new species, *G. thyrrrena*, to which she referred the populations of the Tyrrhenian islands. Greuter *et al.* (1989) accepted the distinction of the four taxa, grouping, however, *G. ephedroides*, *G. gasparrinii* and *G. thyrrrena* in *G. ephedroides* aggr. and keeping *G. numidica* as a separate species. Thus, considering its exclusion from Corse, *G. ephedroides* should be a Sardinian endemic (Valsecchi 1986b; Greuter *et al.* 1989), *G. gasparrinii* (= *Spartium gasparrinii* Guss.) endemic to isolated localities on the northern coast of Sicily (Valsecchi 1986b; Brullo *et al.* 1992), *G. numidica* endemic to the coastal mountains of Algeria (Quezel & Santa 1962; Maire 1987), *G. thyrrrena* endemic to the Arcipelago Ponzianno and to the Isole Eolie (Valsecchi 1986a; Greuter *et al.* 1989). Recently Valsecchi (1993) for the populations of mainland Italy (Salernitano), placed by Pizzolongo

(1960) in *G. ephedroides*, and for eastern populations of Sicily proposed the new species *G. cilentina* Valsecchi. Such Sicilian populations are referred by Brullo *et al.* (1993) to the new species *G. demarcoi* Brullo, Scelsi & Siracusa. In the present paper the specimen of Castelbuono (Sicily) is reported as *G. cilentina*.

Materials and methods

124 samples have been examined in order to assess the intra- and interspecific variability of the taxa of the sect. *Spartocarpus*. Samples of each taxon deriving from several populations, scattered within the respective distributional ranges (Fig. 1), were analysed, this because in previous studies (Feoli Chiapella 1982a, 1983) a certain variability in pollen characters within the same taxon was noted. Pollen from herbarium specimens was acetolysed according to Erdtman (1969), included in glycerine 50% and observed by light microscope (LM).

The following quantitative characters (Plate 1) were examined: length of the polar axis (P), equatorial diameter (E), diameter of the grain at 1/4 of the polar axis ($D_{1/4}$, introduced in order to distinguish rhomboidal grains from ovoidal ones), length of *colpus* (P-c), width of *colpus* (E-c), width of *mesocolpium* (Mes), length of the side of the polar triangle (LTP), thickness of exine measured at the equator of the grain (ExE). For the pollen terminology see Faegri & Iversen (1964), Walker & Doyle (1975), Accorsi & Forlani (1976), Accorsi *et al.* (1983), Feoli Chiapella (1983). The ratios P/E, P/P-c, exine index IE (ExE/E), polar area index IAP (LTP/E) and $E/D_{1/4}$ were considered. The measurements were made by filar ocular micrometer mounted on a Nikon Labophot within a standard period after preparation (4 hours), in order to avoid any alteration in the dimensions (Van Campo 1966; Hanks & Fairbrothers 1976; Rizzi Longo 1986). Thirty measurements for each character and for each sample were made, since the means appear to be stabilised after 20-25 measurements (Rizzi Longo 1986).

The qualitative characters analysed by LM are the shape of the perimeter in polar view (amb), the shape of the apertures and the relative length of thickenings at the end of the furrows. Same as for quantitative measurements, 30 grains have been observed for each population.

The pollen was acetolysed, dehydrated in acetone, dried according to the critical point

technique (Anderson 1951) and coated with gold-palladium for the examination by SEM (Philips Scanning Electron Microscope SEM 500). The exine sculpture at *mesocolpium*, at *apocolpium* and at the margins of the furrows was examined in order to evaluate the morphological variation of the grain surface. The number of pits in a standard area ($49 \mu\text{m}^2$) of the *mesocolpium* has been counted at x 5000.

The species were compared in terms of their pollen characters, both quantitative and qualitative. The quantitative characters were subdivided into classes of regular intervals; the qualitative characters include several states. The average frequency of every quantitative interval and qualitative state was calculated for each taxon. Informational divergence (Lagonegro & Feoli 1981) was used as distance coefficient in order to compare the various taxa. Complete linkage clustering was applied to the matrix of distances to obtain a dendrogram (Sneath & Sokal 1973) and an eigenanalysis to order the taxa (Lagonegro & Feoli 1981). In addition, a minimum spanning tree (MST, Gower & Ross 1969) was constructed, based on the distances, that links the taxa according to maximum affinity. The significance of the differences between averages of the various taxa was assessed for all quantitative characters, using the "t-test" of Student. The computer programs used for classification and ordination are described in Feoli *et al.* (1982).

Results

The results of pollen analysis by LM and SEM are reported in Tab. 2. With regard to quantitative characters, the data for each taxon are averages of the measurements taken from thirty pollen grains from each of the examined samples. As regards qualitative characters, given the variability within the taxa, the average of frequency percentage for each character state is shown.

Fig. 2 represents the dendrogram of the examined taxa based on the characters analysed by LM and SEM (see Tab. 2). It shows the clear division of the taxa into two main clusters. The first cluster is subdivided into two subclusters: A includes *Genista radiata*, *G. holopetala*, *G. hassertiana*, distributed prevalently in the east; B comprises *G. aetnensis*, *G. dorycnifolia*, *G. ephedroides*, *G. gasparrinii*, *G. cilentina* and *G. thyrrana*, Thyrrenian - Balearic taxa. The second cluster likewise is subdivided into two subclusters:

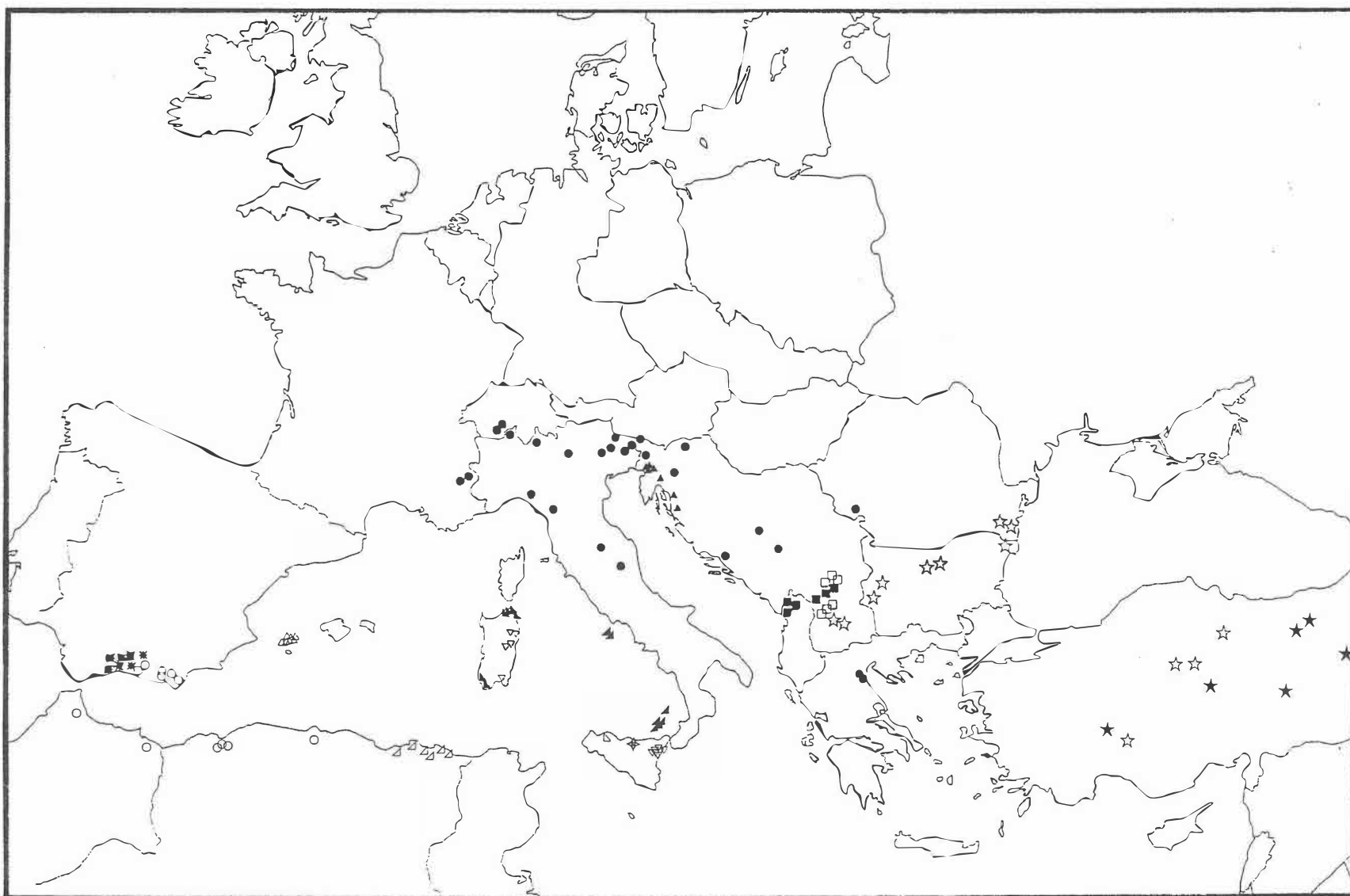


Fig. 1 - Geographical origin of the specimens studied of the taxa of *Genista* sect. *Spartocarpus*: ▽ *G. aetnensis*; ★ *G. aucheri*; ✦ *G. cilentina*; △ *G. dorycnifolia*; ▴ *G. ephedroides*; ▵ *G. gasparrinii*; ✱ *G. haenseleri*; ■ *G. hassertiana*; ▼ *G. holopetala*; □ *G. nissana*; ◐ *G. numidica*; ● *G. radiata*; ☆ *G. sessilifolia*; ○ *G. spartioides*; ▲ *G. thyrrrena*.

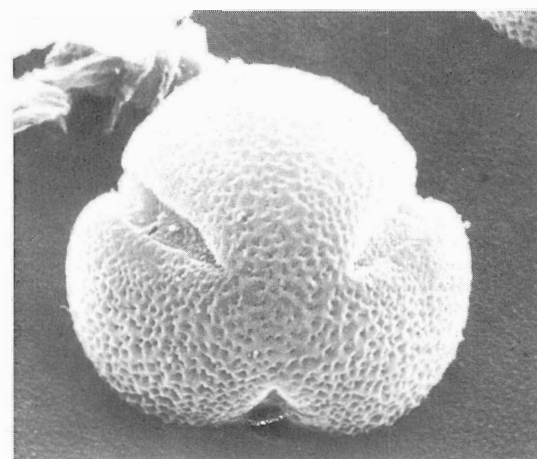
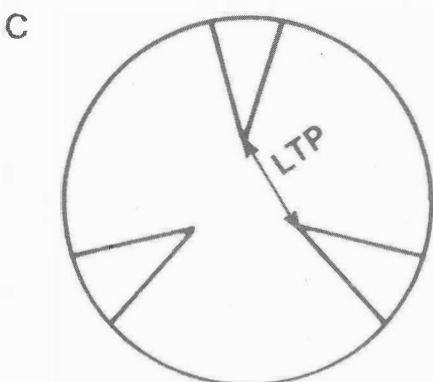
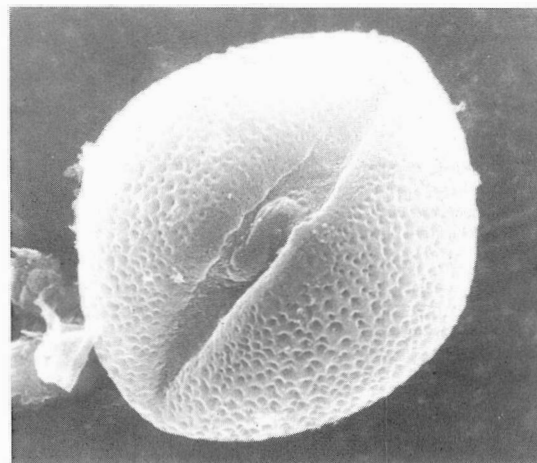
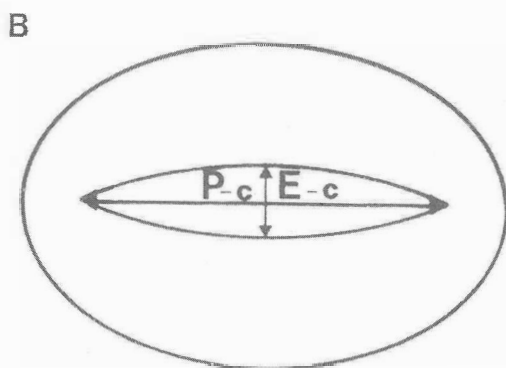
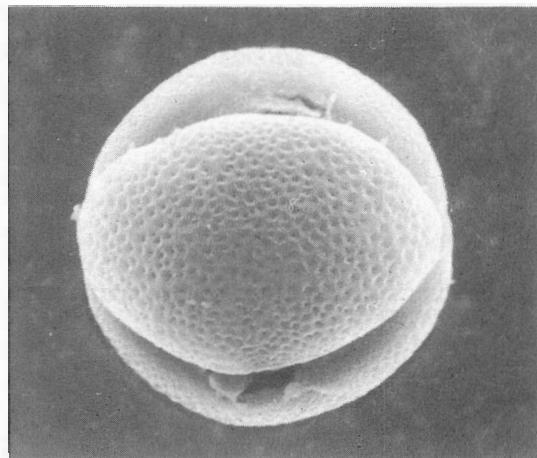
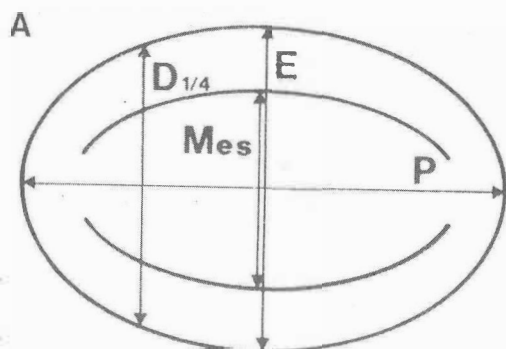


Plate 1 - Diagram of pollen grain of *Genista* in equatorial (A,B) and polar (C) view and photographs by SEM of *G. hassertiana* and *G. holopetala* in equatorial view and of *G. aetnensis* in polar view (x 2,500).

Tab. 2 - Pollen characters in *Genista* sect. *Spartocarpus*. Means and standard deviations (μm) of quantitative characters and average frequencies of qualitative character states by LM and SEM are given.

	<i>G. radiata</i>	<i>G. bolopetala</i>	<i>G. hassertiana</i>	<i>G. sessilifolia</i>	<i>G. nissana</i>	<i>G. aucheri</i>	<i>G. spartioides</i>	<i>G. haenseleri</i>
QUANTITATIVE CHARACTERS (LM)								
P	25.3 $\pm$ 1.51	23.9 $\pm$ 1.10	22.1 $\pm$ 1.64	29.8 $\pm$ 3.12	27.6 $\pm$ 1.48	29.0 $\pm$ 1.50	26.7 $\pm$ 1.09	26.3 $\pm$ 1.68
E	22.0 $\pm$ 1.45	21.8 $\pm$ 1.00	20.6 $\pm$ 0.85	26.6 $\pm$ 2.55	26.5 $\pm$ 1.74	26.0 $\pm$ 1.45	24.4 $\pm$ 1.19	25.3 $\pm$ 0.84
D	15.3 $\pm$ 1.55	14.9 $\pm$ 0.86	14.2 $\pm$ 0.55	18.2 $\pm$ 1.61	17.6 $\pm$ 1.17	20.9 $\pm$ 1.64	19.2 $\pm$ 0.79	19.8 $\pm$ 0.72
P-colpus	23.2 $\pm$ 1.45	22.1 $\pm$ 1.08	19.9 $\pm$ 1.23	26.9 $\pm$ 2.86	25.1 $\pm$ 1.32	23.6 $\pm$ 1.63	22.6 $\pm$ 0.84	22.7 $\pm$ 1.92
E-colpus	1.7 $\pm$ 0.16	1.7 $\pm$ 0.05	1.8 $\pm$ 0.08	1.8 $\pm$ 0.08	1.7 $\pm$ 0.07	2.8 $\pm$ 0.10	1.6 $\pm$ 0.05	2.4 $\pm$ 0.45
Mes	14.3 $\pm$ 1.41	15.0 $\pm$ 1.50	13.8 $\pm$ 0.69	18.2 $\pm$ 2.31	18.4 $\pm$ 1.53	18.9 $\pm$ 1.92	17.6 $\pm$ 1.50	18.6 $\pm$ 1.29
LTP	5.8 $\pm$ 0.67	5.2 $\pm$ 0.28	5.4 $\pm$ 0.57	5.4 $\pm$ 0.72	5.3 $\pm$ 0.30	5.1 $\pm$ 0.72	5.0 $\pm$ 0.76	4.7 $\pm$ 0.65
ExE	1.8 $\pm$ 0.10	1.7 $\pm$ 0.06	1.8 $\pm$ 0.08	1.8 $\pm$ 0.04	1.7 $\pm$ 0.05	2.1 $\pm$ 0.14	1.9 $\pm$ 0.01	1.9 $\pm$ 0.15
P/E	1.1 $\pm$ 0.07	1.1 $\pm$ 0.06	1.1 $\pm$ 1.04	1.1 $\pm$ 0.12	1.0 $\pm$ 0.02	1.1 $\pm$ 0.07	1.1 $\pm$ 0.04	1.0 $\pm$ 0.07
E/D	1.4 $\pm$ 0.09	1.4 $\pm$ 0.14	1.5 $\pm$ 1.32	1.5 $\pm$ 0.05	1.5 $\pm$ 0.03	1.2 $\pm$ 0.04	1.3 $\pm$ 0.05	1.3 $\pm$ 0.04
P/P-colpus	1.1 $\pm$ 0.02	1.1 $\pm$ 0.02	1.1 $\pm$ 1.25	1.1 $\pm$ 0.02	1.1 $\pm$ 0.01	1.2 $\pm$ 0.03	1.2 $\pm$ 0.04	1.2 $\pm$ 0.03
LTP/E	0.2 $\pm$ 0.05	0.2 $\pm$ 0.02	0.3 $\pm$ 0.22	0.2 $\pm$ 0.03	0.2 $\pm$ 0.01	0.2 $\pm$ 0.02	0.2 $\pm$ 0.03	0.2 $\pm$ 0.02
ExE/E	0.1 $\pm$ 0.01	0.1 $\pm$ 0.01	0.1 $\pm$ 0.01	0.1 $\pm$ 0.010	0.1 $\pm$ 0.01	0.1 $\pm$ 0.01	0.1 $\pm$ 0.01	0.1 $\pm$ 0.01
QUALITATIVE CHARACTERS (LM)								
Amb								
peritreme	31.8	26.0	11.2	38.1	36.5	52.8	23.8	31.9
goniotreme	4.2	2.4	0.0	4.8	0.0	3.2	13.3	8.1
ptychotreme	26.9	32.6	39.5	12.5	15.0	2.2	4.5	0.9
perigoniotreme	11.4	16.0	10.0	17.2	18.5	34.0	45.1	48.1
periptychotreme	25.7	23.0	39.3	27.4	30.0	7.8	13.3	11.0
Furrows in face view								
rectangular	59.9	58.9	55.7	55.8	70.6	36.7	19.0	21.8
fusiform	0.9	1.8	1.0	4.7	1.7	5.0	7.2	10.7
with an equatorial constriction	39.2	39.3	43.3	39.5	27.7	58.3	73.8	67.5
with straight margins	78.9	74.6	66.5	62.2	43.2	27.5	21.2	26.7
with wavy margins	21.1	25.4	33.5	37.8	56.8	72.5	78.8	73.3
Furrows in lateral view								
arcuate	76.9	57.1	57.3	52.8	45.0	48.7	38.8	38.3
angular	23.1	42.9	42.7	47.2	55.0	51.3	61.2	61.7
internal edge distinctly delimited	12.8	1.3	3.3	28.4	8.8	76.5	76.9	87.3
internal edge indistinctly delimited	87.2	98.7	96.7	71.6	91.2	23.5	23.1	12.7
Relative length of thickenings at the end of the furrows								
< 1/4	14.3	11.5	17.8	44.3	25.5	14.0	15.2	6.6
= 1/4	34.9	37.1	44.5	23.3	25.5	14.5	24.2	22.3
> 1/4	50.8	51.4	37.7	32.4	49.0	71.5	60.6	71.1
QUALITATIVE CHARACTERS (SEM)								
Exine at mesocolpium								
suprareticulate pitted	74.1	92.0	85.0	76.0	87.5	70.0	81.5	96.0
with insulae	11.9	6.0	8.0	7.9	7.5	3.0	3.5	4.0
ridged	1.9	1.0	1.0	11.2	1.7	3.0	6.0	0.0
rugulate	9.9	1.0	5.0	1.0	3.3	9.0	0.0	0.0
grooved	1.4	0.0	1.0	0.8	0.0	5.0	0.0	0.0
smooth	0.8	0.0	0.0	3.1	0.0	10.0	9.0	0.0
tapered muri	67.4	75.9	71.9	57.9	84.2	65.0	71.9	71.0
rounded off muri	32.6	24.1	28.1	42.1	15.8	35.0	28.1	29.0
lumina with regular pits	65.6	36.0	40.0	76.8	58.4	52.0	44.5	27.0
lumina with irregular pits	7.3	28.0	15.0	5.0	10.0	16.0	21.0	31.0
lumina with more than one pits	4.5	21.0	18.0	4.7	10.8	5.0	2.5	2.0
lumina with joined pits	17.6	10.0	8.0	11.7	13.3	22.0	6.0	9.0
lumina with granular processes	5.0	5.0	19.0	1.8	7.5	5.0	26.0	31.0
Exine at apocolpium								
similar to exine at mesocolpium	80.3	75.0	81.0	69.0	72.5	89.0	82.0	83.0
with less raised reticulum	12.3	9.0	9.0	17.4	11.7	1.0	8.0	6.0
with reduced number of pits	7.2	16.0	10.0	13.6	15.8	10.0	10.0	7.0
with increased number of pits	0.2	0.0	0.0	0.0	0.0	0.0	0.0	4.0
Exine at furrow margin								
similar to exine at mesocolpium	14.0	20.0	0.0	0.0	18.0	12.0	15.0	14.0
more finely reticulate	67.0	40.0	80.0	15.0	35.0	57.0	55.0	43.0
with margo	19.0	40.0	20.0	85.0	47.0	31.0	30.0	43.0
with reduced number of pits	33.0	40.0	40.0	93.0	75.0	46.0	47.0	57.0
with increased number of pits	67.0	60.0	60.0	7.0	25.0	54.0	53.0	43.0
Furrow membrane								
smooth	8.0	0.0	14.1	12.6	0.0	19.8	20.6	0.0
microgranular	28.6	39.2	18.2	62.8	99.0	60.1	48.7	40.1
granular	48.6	59.8	59.6	10.8	1.0	0.0	20.6	59.9
warty	14.8	1.0	8.1	13.8	0.0	20.1	10.1	0.0
Number of pits at mesocolpium μm^{-2}								
0.8 - 1.6	17.4	40.0	-	22.2	-	-	-	-
1.7 - 2.4	26.0	60.0	20.0	55.6	33.3	1.0	66.0	100.0
2.5 - 3.2	26.0	-	20.0	22.2	50.0	99.0	3.0	-
3.3 - 4.1	26.0	-	60.0	-	16.7	-	1.0	-
4.2 - 4.9	4.6	-	-	-	-	-	30.0	-

- Systematics of *Genista* sect. *Spartocarpus* -

	<i>G. numidica</i>	<i>G. dorycnifolia</i>	<i>G. aetnensis</i>	<i>G. ephedroides</i>	<i>G. thyrrina</i>	<i>G. gasparrinii</i>	<i>G. cilentina</i>
QUANTITATIVE CHARACTERS (LM)							
P	27.2 ± 1.93	23.2 ± 1.67	24.1 ± 2.45	24.8 ± 2.13	24.7 ± 0.98	24.0 ± 2.12	22.9 ± 2.12
E	24.1 ± 1.47	23.4 ± 0.83	23.7 ± 1.26	23.4 ± 0.52	23.7 ± 1.14	22.8 ± 0.84	23.7 ± 0.84
D	19.5 ± 1.56	18.2 ± 0.90	17.8 ± 1.57	17.6 ± 0.23	18.1 ± 1.00	16.8 ± 0.92	17.7 ± 0.92
P-colpus	24.0 ± 0.99	19.4 ± 1.91	19.3 ± 2.06	19.5 ± 1.23	19.9 ± 0.78	19.5 ± 2.11	17.9 ± 2.11
E-colpus	2.9 ± 0.45	2.8 ± 0.15	2.0 ± 0.45	1.7 ± 0.05	1.7 ± 0.25	1.8 ± 0.25	1.8 ± 0.07
Mes	18.5 ± 2.22	17.4 ± 0.93	15.9 ± 1.47	15.2 ± 1.32	15.3 ± 1.32	17.1 ± 0.34	15.6 ± 0.34
LTP	5.4 ± 0.84	4.5 ± 0.44	5.7 ± 1.18	5.3 ± 0.42	5.4 ± 0.62	5.3 ± 0.80	5.7 ± 0.80
ExE	2.0 ± 0.15	1.9 ± 0.45	1.9 ± 0.01	1.8 ± 0.15	1.8 ± 0.05	1.9 ± 0.14	1.7 ± 0.05
P/E	1.1 ± 0.14	1.0 ± 0.06	1.0 ± 0.07	1.0 ± 0.08	1.0 ± 0.03	1.06 ± 0.03	0.96 ± 0.03
E/D	1.2 ± 0.08	1.3 ± 0.05	1.3 ± 0.10	1.3 ± 0.03	1.3 ± 0.02	1.34 ± 0.01	1.33 ± 0.01
P/P-colpus	1.1 ± 0.01	1.2 ± 0.03	1.2 ± 0.04	1.2 ± 0.03	1.2 ± 0.03	1.22 ± 0.01	1.27 ± 0.01
LTP/E	0.2 ± 0.04	0.2 ± 0.02	0.2 ± 0.04	0.2 ± 0.02	0.2 ± 0.03	0.22 ± 0.01	0.23 ± 0.01
ExE/E	0.1 ± 0.01	0.1 ± 0.01	0.1 ± 0.01	0.08 ± 0.01	0.1 ± 0.01	0.08 ± 0.02	0.07 ± 0.02
QUALITATIVE CHARACTERS (LM)							
Amb							
peritreme	38.3	38.0	14.0	9.8	15.9	0.0	17.0
goniotreme	12.5	11.6	6.1	22.2	18.9	53.0	20.0
ptychotreme	5.5	1.9	7.9	0.5	1.7	0.0	0.0
perigoniotreme	32.7	42.0	48.7	57.2	49.2	47.0	53.0
peripitychotreme	11.0	6.5	23.3	10.3	14.3	0.0	10.0
Furrows in face view							
rectangular	26.5	31.1	29.0	10.0	19.1	10.0	27.0
fusiform	10.7	7.3	5.7	4.3	3.7	0.0	0.0
with an equatorial constriction	62.8	61.6	65.3	85.7	77.2	90.0	53.0
with straight margins	23.3	38.7	19.8	1.3	2.3	0.0	0.0
with wavy margins	76.7	61.3	80.2	98.7	97.7	99.0	99.0
Furrows in lateral view							
arcuate	43.7	26.7	58.8	26.2	39.3	49.0	73.0
angular	56.3	73.3	41.2	73.8	60.7	52.5	25.5
internal edge distinctly delimit	94.8	82.0	47.9	58.3	45.8	43.0	30.0
internal edge indistinctly delimit	5.2	18.0	52.1	41.7	54.1	57.0	70.0
Relative length of thickenings at the end of the furrows							
< 1/4	33.3	16.6	32.4	12.8	4.6	0.0	23.0
= 1/4	31.7	18.4	24.4	20.5	26.4	23.0	50.0
> 1/4	35.0	65.0	43.2	66.7	69.0	77.0	27.0
QUALITATIVE CHARACTERS (SEM)							
Exine at mesocolpium							
suprareticulate pitted	95.0	94.0	94.3	83.3	91.3	95.0	95.0
with insulae	5.0	5.0	5.7	10.0	8.7	5.0	5.0
ridged	0.0	0.0	0.0	0.0	0.0	0.0	0.0
rugulate	0.0	1.0	0.0	6.7	0.0	0.0	0.0
grooved	0.0	0.0	0.0	0.0	0.0	0.0	0.0
smooth	0.0	0.0	0.0	0.0	0.0	0.0	0.0
tapered muri	82.5	69.0	65.0	81.7	72.5	70.0	95.0
rounded off muri	17.5	31.0	35.0	18.3	27.5	30.0	5.0
lumina with regular pits	85.0	64.0	68.0	88.4	72.7	75.0	95.0
lumina with irregular pits	10.0	10.0	12.5	3.3	8.7	15.0	5.0
lumina with more than one pit	2.5	8.0	10.0	0.0	1.2	5.0	0.0
lumina with joined pits	0.0	12.0	6.3	8.3	8.7	0.0	0.0
lumina with granular processes	2.5	6.0	3.2	0.0	8.7	5.0	0.0
Exine at apocolpium							
similar to exine at mesocolpium	77.5	73.0	87.4	55.0	80.1	60.0	93.0
with less raised reticulum	12.5	5.0	6.9	20.0	7.5	20.0	5.0
with reduced number of pits	10.0	22.0	5.7	25.0	11.2	20.0	2.0
with increased number of pits	0.0	0.0	0.0	0.0	1.2	0.0	0.0
Exine at furrow margin							
similar to exine at mesocolpium	0.0	5.0	10.0	0.0	0.0	0.0	0.0
more finely reticulate	45.0	5.0	62.0	65.0	25.0	36.0	70.0
with margo	55.0	90.0	28.0	35.0	75.0	64.0	30.0
with reduced number of pits	60.0	90.0	66.0	35.0	75.0	74.0	20.0
with increased number of pits	40.0	10.0	44.0	65.0	25.0	26.0	80.0
Furrow membrane							
smooth	0.0	19.8	0.0	0.0	0.0	0.0	0.0
microgranular	0.0	40.1	50.0	67.0	0.0	0.0	1.0
granular	94.9	40.1	50.0	33.0	95.0	90.0	99.0
warty	5.1	0.0	0.0	0.0	5.0	10.0	0.0
Number of pits at mesocolpium .µm ⁻²							
0.8 - 1.6	43.0						
1.7 - 2.4	57.0	67.0	13.0	67.0	33.0	60.0	33.3
2.5 - 3.2		17.0	49.0	33.0	67.0	40.0	66.7
3.3 - 4.1		16.0	13.0				
4.2 - 4.9			25.0				

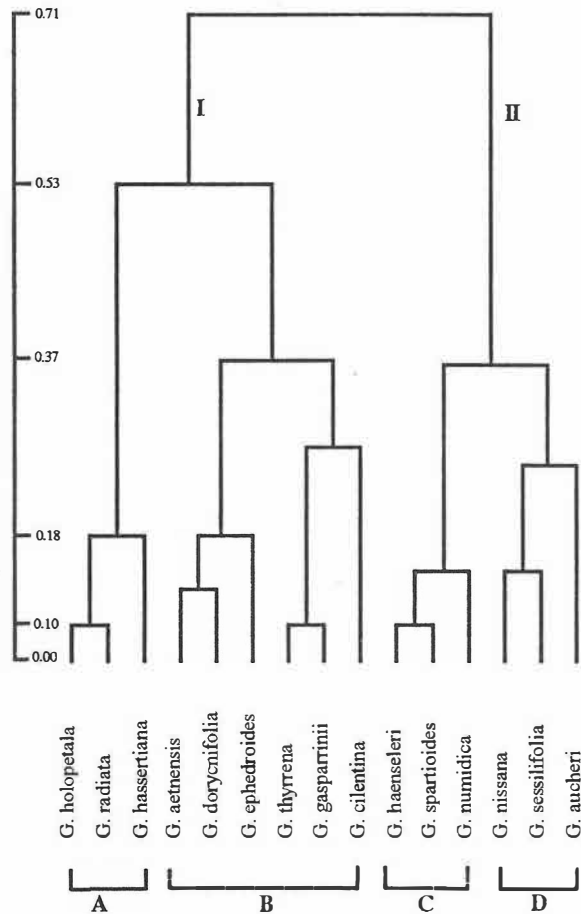


Fig. 2 - Dendrogram of the taxa of the sect. *Spartocarpus* based on the quantitative and qualitative pollen characters of Tab. 2.

C includes *G. haenseleri* and *G. spartioides*, which are very similar, and, a little separated, *G. numidica*; these are the western- and southernmost (north-western Africa) species of the section; D includes *G. nissana*, *G. sessilifolia* and, a little separated, *G. aucheri*, all taxa with an eastern distribution.

As regards quantitative pollen characters (see Tab. 2), the taxa in cluster II are characterised by larger dimensions of the polar axis (26.3-29.8 μm), of the equatorial diameter (24.1-26.6 μm) and of the width of *mesocolpium* (17.6-18.9 μm) in comparison with those of the taxa of cluster I (P: 22.1-25.3 μm ; E: 20.6-23.7 μm ; Mes: 13.8-17.4 μm). In cluster II *Genista haenseleri*, *G. spartioides* and *G. numidica* (subcluster C) are clearly distinguished from *G. nissana*, *G. sessilifolia* and *G. aucheri* (subcluster D) by the dimensions of the axes P ed E. The two subclusters of cluster I display even greater diversity: the width (E, D, Mes) and the ratios P/E, E/D, P/P-colpus

clearly distinguish *G. radiata*, *G. holopetala*, *G. hassertiana* (subcluster A) from *G. aetnensis*, *G. dorycnifolia*, *G. ephedroides*, *G. thyrrina*, *G. gasparrinii* and *G. cilentina* (subcluster B). Fig. 3a shows the ordination of the species based on the quantitative characters measured by LM. There is a clear separation, along the second principal axis, between the species of cluster I (subclusters A, B) and those of cluster II (subclusters C, D). Subclusters A and B are clearly separated along the third principal axis, while subclusters C and D are not so well characterized.

Tab. 3 shows the results of the comparison of the taxa according to the "t-test" of Student, carried out in order to assess the significance of the difference between averages of quantitative characters. The number of differential characters between the taxa (probability level 0.5) is reported. Among the four subclusters described on the basis of the dendrogram of Fig. 2, subcluster A seems to be the most heterogeneous: in particular three characters distinguish *Genista hassertiana* from *G. holopetala* and *G. radiata*. On the contrary, in subcluster D, no differential character distinguishes *G. nissana* and *G. sessilifolia*, while *G. aucheri* is distinguished from the others by one and two characters, respectively. Among the western species, *G. haenseleri*, *G. spartioides* and *G. numidica* (subcluster C) are remarkably

	A			D			C			B		
	<i>G. radiata</i>	<i>G. holopetala</i>	<i>G. hassertiana</i>	<i>G. sessilifolia</i>	<i>G. nissana</i>	<i>G. aucheri</i>	<i>G. spartioides</i>	<i>G. haenseleri</i>	<i>G. numidica</i>	<i>G. dorycnifolia</i>	<i>G. aetnensis</i>	<i>G. ephedroides</i>
<i>G. radiata</i>	X	2	3	5	5	5	5	4	4	6	3	3
<i>G. holopetala</i>		X	3	5	5	4	3	4	5	4	3	3
<i>G. hassertiana</i>			X	5	5	5	5	5	5	4	3	3
<i>G. sessilifolia</i>				X	0	2	3	3	2	4	3	3
<i>G. nissana</i>					X	1	3	2	2	4	3	3
<i>G. aucheri</i>						X	3	1	1	4	4	4
<i>G. spartioides</i>							X	0	1	3	3	3
<i>G. haenseleri</i>								X	0	4	3	3
<i>G. numidica</i>									X	3	3	2
<i>G. dorycnifolia</i>										X	1	1
<i>G. aetnensis</i>											X	0
<i>G. ephedroides</i>												X
<i>G. thyrrina</i>												

Tab. 3 - Number of quantitative pollen characters discriminant at significant level between the taxa of the sect. *Spartocarpus* according to the "t-test" of Student (probability level: 0.5), with the exception of *G. gasparrinii* and *G. cilentina*. The subclusters A-D of the classification of fig. 2 are reported.

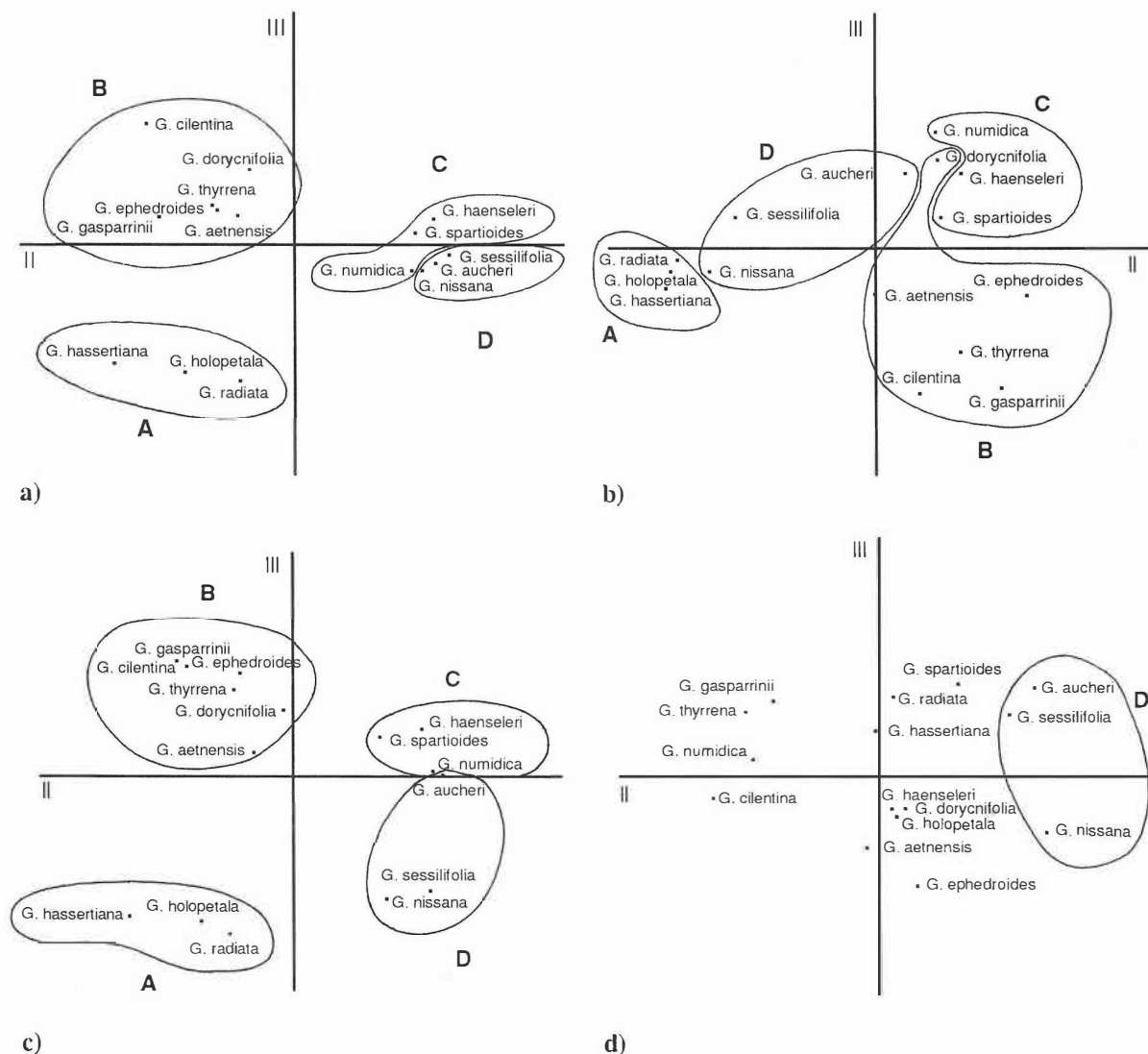


Fig. 3 - Ordinations of the taxa of the sect. *Spartocarpus* on the basis of: a) quantitative pollen characters analysed by LM; b) qualitative pollen characters analysed by LM; c) quantitative and qualitative pollen characters analysed by LM; d) qualitative pollen characters analysed by SEM.

homogeneous; only *G. numidica* has a single differential character towards *G. spartioides*. The other western species (subcluster B) are likewise considerably homogeneous: the Balearic endemic *G. dorycnifolia* is distinguished from the Tyrrhenian species *G. aetnensis*, *G. ephedroides* and *G. thyrrrena* by a single character; none of these three species has any differential character with the others. The species of subcluster A display the greater diversity, particularly with respect to the eastern species of subcluster D, and to the western species of subcluster C.

The two main clusters in Fig. 2 are not

completely recognizable on the basis of qualitative characters examined by LM (see Tab. 2); there is no differential character separating them. On the contrary, a distinction is possible among some subclusters: the furrows distinguish subcluster C from D; subcluster A is distinguished from B, not only by the furrows, but by the amb too. *Genista radiata*, *G. holopetala* and *G. hassertiana* (subcluster A) in comparison with the other species of sect. *Spartocarpus*, show a higher percentage of ptychotreme grains and furrows with straight margins. The above mentioned distinctions are recognizable in the ordination of the taxa of sect.

Spartocarpus based on qualitative characters examined by LM (Fig. 3b).

Fig. 3c shows the ordination of the species based on all characters, both quantitative and qualitative, examined by LM. The characterization of the four subclusters is here more precise than in the ordinations of Figs. 3a, b; subclusters C and D, still not so well recognizable through the analysis of quantitative characters alone, are here better characterized.

The exine sculpture observed by SEM shows a certain variation both within species and within clusters: a cluster is rarely distinguishable on the basis of the exine characters examined by SEM at *mesocolpium* (Plate 2), at *apocolpium* and at the margins of the furrows (Plate 3). Anyway, single species may show a higher frequency of certain characters without being clearly characterized by this. Fig. 3d shows the ordination of the species based on the characters of the exine as examined by SEM. Only subcluster D is characterized clearly enough, even though its species are not very close.

Fig. 4 shows the ordination, based on all characters, both qualitative and quantitative, examined by LM and SEM, and the overimposed MST of the taxa. The four subclusters, already recognizable in the dendrogram of Fig. 2 and in the ordinations of Fig. 3 are even better characterized in the ordination of Fig. 4. The second axis separates the species of subclusters A and B, on the right, from those of subclusters C and D, on the left. The third axis separates the eastern species with capitate inflorescence (subcluster A) from the Tyrrhenian and the Balearic ones (subcluster B), and the eastern taxa with long racemes (subcluster D) from the Spanish and north-African ones (subcluster C). Subcluster A is the most isolated, having the lowest similarity coefficients towards the others. *G. dorycnifolia*, a Balearic endemic, links subclusters B and C. It is interesting to observe that *G. numidica* is closer to *G. haenseleri* and *G. spartioides* (subcluster C) than to *G. ephedroides*, *G. thyrrena*, *G. gasparrinii* and *G. cilentina* (subcluster B). *G. aucheri* is a link between subclusters C and D.

Different groups of populations of *Genista radiata*, *G. sessilifolia*, *G. spartioides* and *G. aetnensis* were studied separately (Tab. 4). These species have such a range disjunction and/or such a high morphological variability as to induce some authors to propose the creation of infraspecific taxa.

Fig. 5 shows the ordination, with MST overimposed, of the taxa, on the basis of all

qualitative and quantitative characters, taking into account the various groups of populations (see Tabs. 2, 4).

As regards *Genista radiata*, the populations of the more eastern var. *radiata* and those of the more western var. *sericopetala* have been examined. The two varieties, although separated on pollen characters, show a close affinity.

As for *Genista sessilifolia*, three different groups of populations have been examined: the populations of the region of Dobruja in Romania (ssp. *romanica* sensu Gibbs), the populations of Bulgaria and of Makedonija, and those of Turkey. The three groups of populations are distinct, more or less equidistant and with a medium pollen affinity.

As regards *Genista spartioides*, populations of southern Spain and north-western Africa have been examined separately. Although they show a close affinity, they turned out to be distinct on the basis of pollen characters.

Sardinian and Sicilian populations of *Genista aetnensis* have been examined separately. The two groups of populations turned out to be very different on the basis of pollen characters. The Sardinian populations show their closest affinity with the taxa of *G. ephedroides* complex through *G. thyrrena*; the Sicilian populations are more isolated, though still linked to *G. ephedroides*; the two groups of populations have a low coefficient of similarity.

Discussion

Genista radiata, *G. holopetala* and *G. hassertiana* (subcluster A), a group with centre of distribution in the east-Alpine Balkan area, are rather similar on the basis of the pollen characters (see Figs. 2-5). They display both a remarkable morphological similarity - opposite branches, trifoliolate opposite leaves, capitate inflorescence (Spach 1844; Buchegger 1912; Fukarek 1964; Pignatti 1982) - and a karyological homogeneity: $2n = 48$ in *G. radiata* var. *radiata* (Cusma Velari & Feoli Chiapella 1987a) and in *G. holopetala* (Cusma Velari & Feoli Chiapella 1987b), $2n = 96$ in *G. radiata* var. *sericopetala* (Zickler 1968; Cusma Velari & Feoli Chiapella 1987a; Verlaque *et al.* 1987). These species are the only ones in the section displaying a capitate inflorescence and therefore are grouped by Mayer (1970) in the series "Capitati" of *Cytisanthus*. Their cluster based on pollen characters is the most isolated.

All the other species of the section have

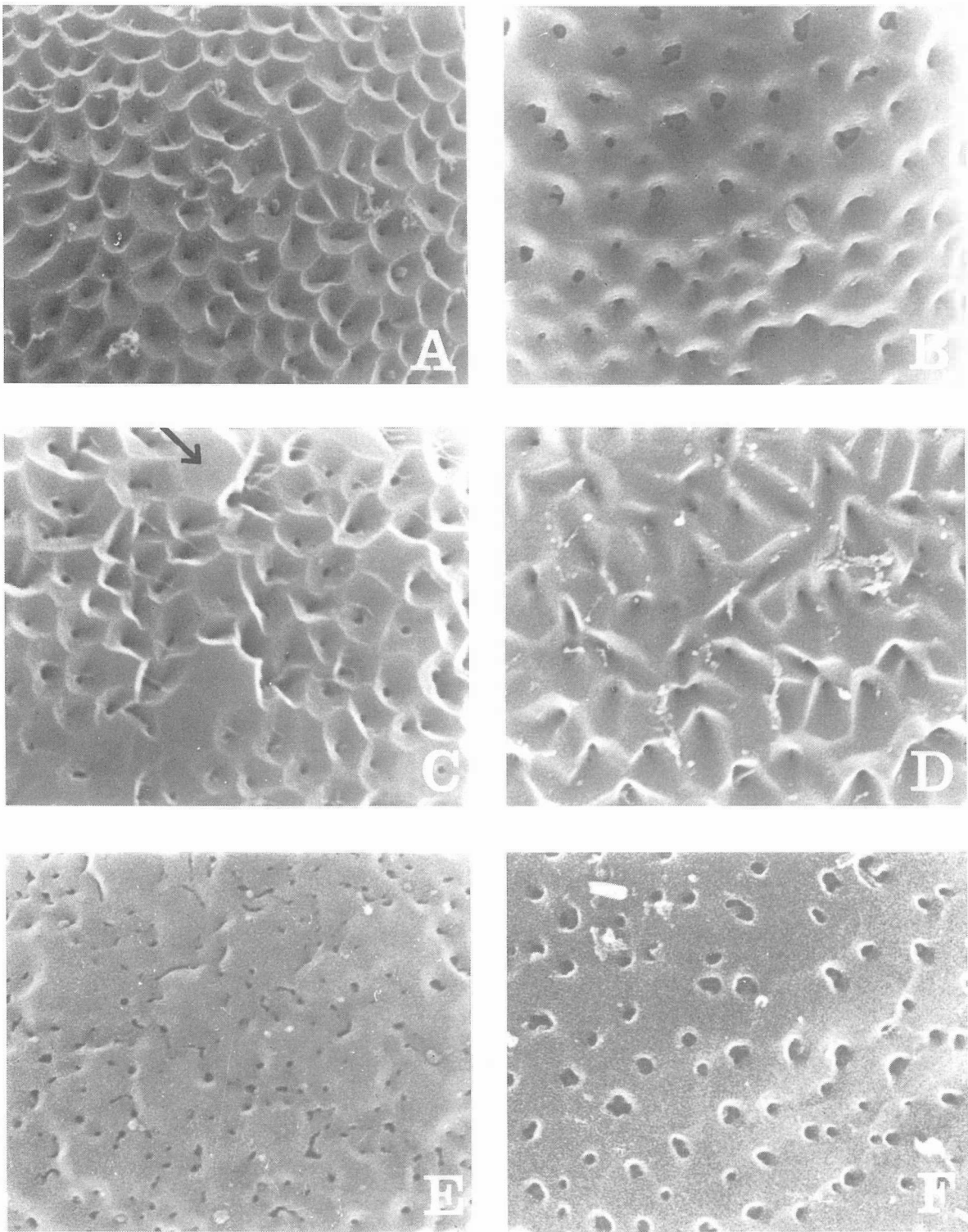


Plate 2 - Exine sculpture of the pollen of the taxa of *Genista* sect. *Spartocarpus* analysed by SEM (×10,000) at mesocolpium. A - suprareticulate pitted exine, tapered muri, lumina with regular pits (*G. numidica*); B - suprareticulate pitted exine, rounded off muri, lumina with irregular pits (*G. aetnensis*); C - exine with insulae, arrowed (*G. thyrrana*); D - ridged exine (*G. sessilifolia*); E - rugulate exine (*G. ephedroides*); F - smooth exine (*G. spartioides*).

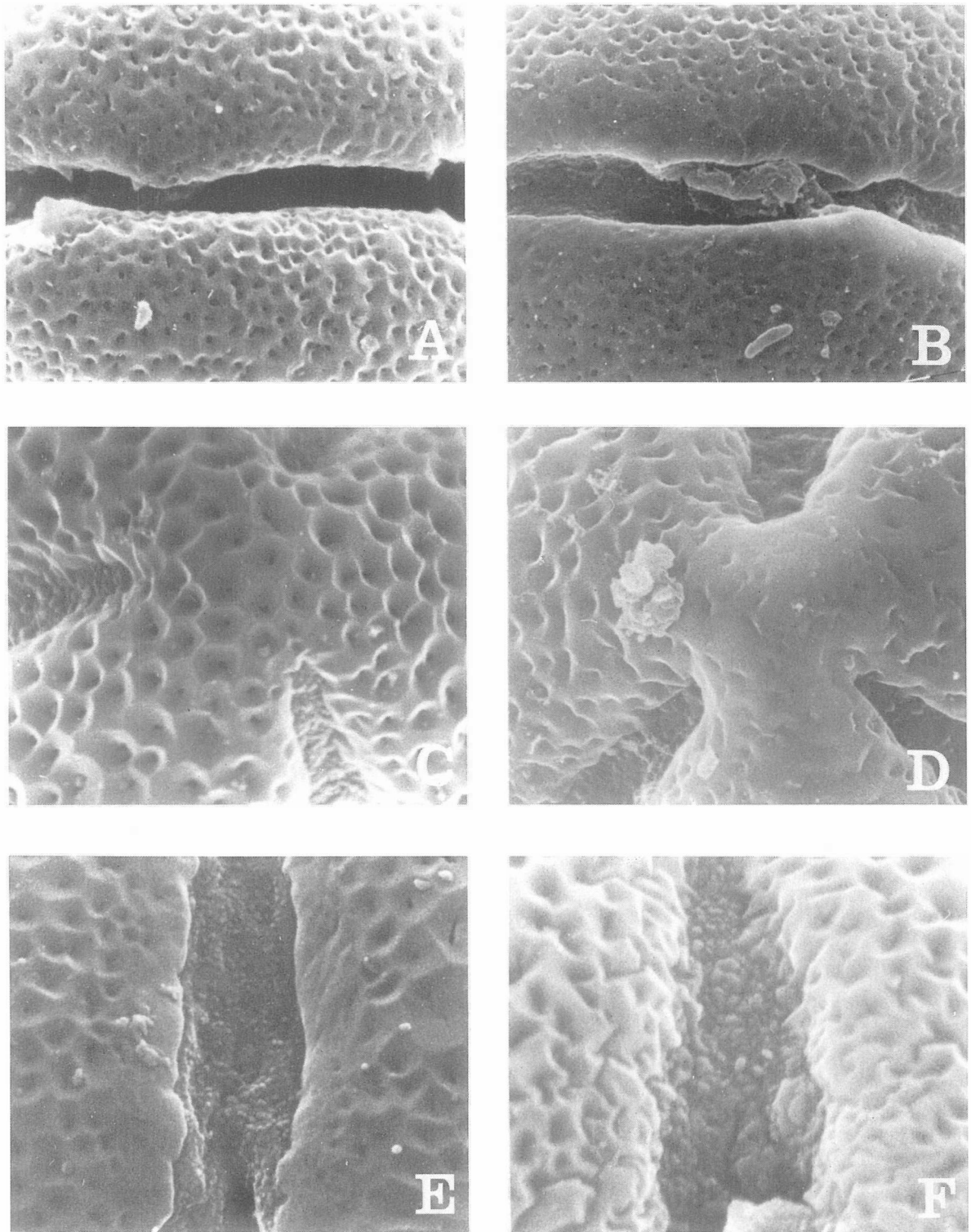


Plate 3 - Exine sculpture of the pollen of the taxa of *Genista* sect. *Spartocarpus* analysed by SEM at furrow margin (A, B) and at apocolpium (C, D); furrow membrane (E, F). A - exine similar to exine at mesocolpium (*G. holopetala* - x 5,000); B - with margo (*G. dorycnifolia* - x 5,000); C - exine similar to exine at mesocolpium (*G. haenseleri* - x 10,000); D - with less raised reticulum (*G. radiata* - x 10,000); E - microgranular furrow membrane (*G. nissana* - x 10,000); F - warty furrow membrane (*G. aucheri* - x 10,000).

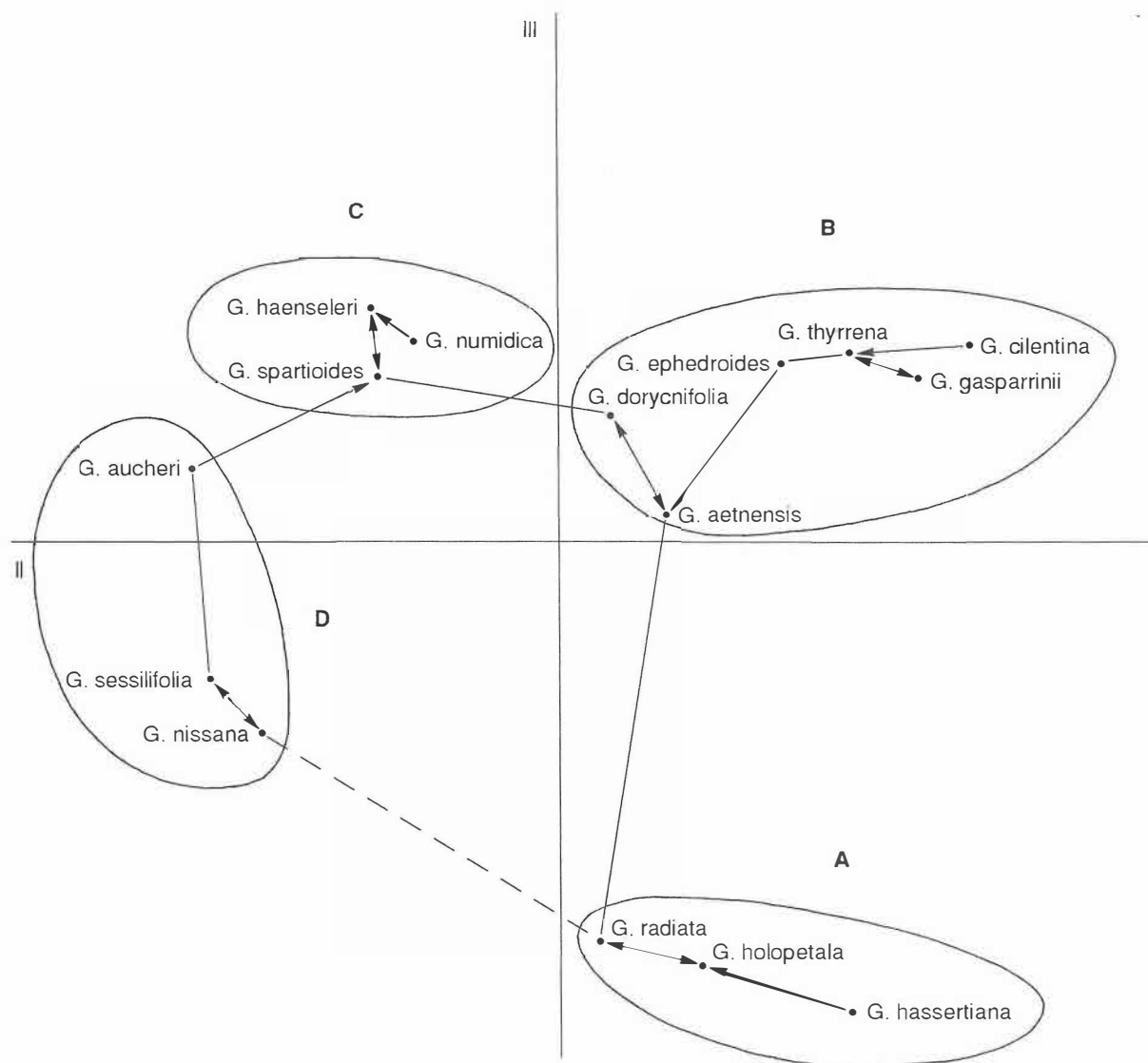


Fig. 4 - Ordination and minimum spanning tree of the taxa of the sect. *Spartocarpus* on the basis of the quantitative and qualitative pollen characters of Tab. 2.

diversified racemous inflorescences. These species can be grouped in three subclusters (B, C, D) on the basis of pollen characters (see Figs. 2-5). They also differ in distribution and in morphological characters.

Subcluster D comprises *Genista sessilifolia*, *G. nissana* and, even if more separated, *G. aucheri*, distributed in the central and southern Balkans and in Anatolia. They are homogeneous, both morphologically (subopposite or alternate branches, trifoliolate, alternate and subopposite leaves, long racemes) and palynologically. The first two species were included by Mayer (1970) in series "Racemosi" of *Cytisanthus*. As for *G. sessilifolia*,

the pollen analysis seems to confirm the existence of ssp. *romanica* sensu Gibbs, limited to the Rumanian populations. Inside ssp. *sessilifolia* sensu Gibbs, it might be more correct to separate the Turkish populations [corresponding to ssp. *sessilifolia* sensu Greuter *et al.* (1989)] from the European ones. These would correspond to *G. trifoliolata* p.p. [= *G. sessilifolia* subsp. *romanica* sensu Greuter *et al.* (1989) p.p.], i.e. limited to the European populations, those from Romania excluded. *G. aucheri*, an Anatolian endemic, with interrupted racemes and opposite flowers, is intermediate between *G. sessilifolia* (subcluster D), that also has similar morphological characters and

Tab. 4 - Pollen characters in different groups of populations of *Genista radiata*, *G. sessilifolia*, *G. spartioides* and *G. aetnensis*. Means and standard deviations (μm) of quantitative characters and average frequencies of qualitative character states by LM and SEM are given.

	<i>G. radiata</i> var. <i>radiata</i>	<i>G. radiata</i> var. <i>sericopetala</i>	<i>G. sessilifolia</i> ssp. <i>romantica</i>	<i>G. sessilifolia</i> ssp. <i>sessilifolia</i> (Europe)	<i>G. sessilifolia</i> ssp. <i>sessilifolia</i> (Turkey)	<i>G. spartioides</i> (Spain)	<i>G. spartioides</i> (Africa)	<i>G. aetnensis</i> (Sicily)	<i>G. aetnensis</i> (Sardinia)
QUANTITATIVE CHARACTERS (LM)									
P	25.0 $\pm$ 1.37	26.3 $\pm$ 1.68	32.5 $\pm$ 1.20	28.1 $\pm$ 2.25	31.5 $\pm$ 3.52	27.0 $\pm$ 1.54	26.4 $\pm$ 0.47	25.5 $\pm$ 2.02	22.0 $\pm$ 1.76
E	21.8 $\pm$ 1.29	22.9 $\pm$ 1.82	31.0 $\pm$ 0.78	26.3 $\pm$ 2.20	24.9 $\pm$ 1.10	24.4 $\pm$ 1.66	24.4 $\pm$ 0.82	24.3 $\pm$ 1.19	22.9 $\pm$ 1.04
D	15.1 $\pm$ 1.36	15.9 $\pm$ 2.10	20.5 $\pm$ 0.71	17.7 $\pm$ 1.46	17.8 $\pm$ 1.35	19.6 $\pm$ 0.70	18.9 $\pm$ 0.87	18.4 $\pm$ 1.60	16.9 $\pm$ 1.37
P-colpus	23.0 $\pm$ 1.39	24.0 $\pm$ 1.57	29.4 $\pm$ 1.13	25.4 $\pm$ 2.16	28.3 $\pm$ 3.71	22.7 $\pm$ 1.11	22.6 $\pm$ 0.88	20.3 $\pm$ 1.88	17.8 $\pm$ 1.67
E-colpus	1.7 $\pm$ 0.15	1.8 $\pm$ 0.16	1.8 $\pm$ 0.07	1.8 $\pm$ 0.08	1.9 $\pm$ 0.05	1.7 $\pm$ 0.01	1.6 $\pm$ 0.01	1.7 $\pm$ 0.01	2.3 $\pm$ 0.64
Mes	14.0 $\pm$ 1.38	15.4 $\pm$ 1.21	22.0 $\pm$ 1.84	18.1 $\pm$ 1.63	16.5 $\pm$ 1.58	17.3 $\pm$ 1.34	17.9 $\pm$ 1.84	15.6 $\pm$ 1.38	16.4 $\pm$ 1.79
LTP	5.8 $\pm$ 0.59	5.8 $\pm$ 0.95	5.5 $\pm$ 0.49	5.6 $\pm$ 0.88	4.8 $\pm$ 0.20	5.0 $\pm$ 0.95	4.9 $\pm$ 0.71	6.5 $\pm$ 0.37	4.6 $\pm$ 1.11
ExE	1.8 $\pm$ 0.11	1.7 $\pm$ 0.07	1.8 $\pm$ 0.01	1.8 $\pm$ 0.06	1.8 $\pm$ 0.01	1.9 $\pm$ 0.01	1.9 $\pm$ 0.01	1.9 $\pm$ 0.01	1.9 $\pm$ 0.01
P/E	1.1 $\pm$ 0.08	1.1 $\pm$ 0.04	1.0 $\pm$ 0.06	1.1 $\pm$ 0.05	1.3 $\pm$ 0.13	1.1 $\pm$ 0.04	1.1 $\pm$ 0.04	1.04 $\pm$ 0.07	1.0 $\pm$ 0.07
E/D	1.5 $\pm$ 0.09	1.5 $\pm$ 0.08	1.5 $\pm$ 0.02	1.5 $\pm$ 0.03	1.4 $\pm$ 0.06	1.2 $\pm$ 0.07	1.3 $\pm$ 0.04	1.32 $\pm$ 0.10	1.4 $\pm$ 0.12
P/P-colpus	1.1 $\pm$ 0.05	1.1 $\pm$ 0.02	1.1 $\pm$ 0.01	1.1 $\pm$ 0.02	1.1 $\pm$ 0.01	1.2 $\pm$ 0.04	1.2 $\pm$ 0.03	1.25 $\pm$ 0.04	1.2 $\pm$ 0.05
LTP/E	0.3 $\pm$ 0.04	0.2 $\pm$ 0.04	0.2 $\pm$ 0.01	0.2 $\pm$ 0.04	0.2 $\pm$ 0.01	0.2 $\pm$ 0.04	0.2 $\pm$ 0.03	0.26 $\pm$ 0.02	0.2 $\pm$ 0.05
ExE/E	0.1 $\pm$ 0.01	0.1 $\pm$ 0.01	0.1 $\pm$ 0.01	0.1 $\pm$ 0.01	0.1 $\pm$ 0.01	0.1 $\pm$ 0.01	0.1 $\pm$ 0.01	0.07 $\pm$ 0.01	0.1 $\pm$ 0.01
QUALITATIVE CHARACTERS (LM)									
Amb									
peritreme	24.6	62.0	30.0	47.7	25.0	30.5	0.7	0.2	28.8
goniotreme	5.0	0.0	5.0	0.1	0.3	0.3	0.8	0.2	0.4
pychotreme	28.3	0.9	5.0	10.0	0.8	0.3	0.0	0.5	0.0
perigoniotreme	0.5	0.3	0.5	0.8	0.7	42.5	47.8	45.2	53.8
peripychotreme	29.5	0.4	48.5	0.8	28.4	11.0	0.6	33.3	0.3
Furrows in face view									
rectangular	58.6	65.2	72.0	47.8	61.5	0.6	1.0	37.1	0.6
fusiform	0.0	0.0	0.0	0.2	5.0	0.2	0.4	0.4	2.0
with an equatorial constriction	40.6	33.4	26.5	46.7	33.5	80.8	66.8	53.7	82.4
with straight margins	78.9	78.6	78.5	60.3	57.5	0.8	0.9	0.7	26.6
with wavy margins	0.9	0.9	0.9	39.7	42.5	80.3	77.3	83.7	73.4
Furrows in lateral view									
arcuate	76.8	77.2	73.0	45.9	54.8	34.3	43.2	68.6	44.2
angular	1.0	0.9	27.0	54.1	45.2	65.7	56.8	31.4	55.8
internal edge distinctly delimited	0.6	0.3	35.0	0.2	67.3	78.8	75.2	36.1	68.6
internal edge indistinctly delimited	85.9	92.8	65.0	95.7	32.7	0.9	24.8	63.9	31.4
Relative length of thickenings at the end of the furrows									
< 1/4	0.7	0.1	75.0	27.0	59.2	0.7	0.5	56.3	2.0
= 1/4	31.4	49.4	1.0	27.6	0.6	0.8	38.8	29.0	0.5
> 1/4	51.4	48.4	0.0	45.4	25.0	62.8	58.5	0.6	85.8
QUALITATIVE CHARACTERS (SEM)									
Exine at mesocolpium									
supra-reticulate pitted	78.1	57.4	79.0	78.0	71.0	78.0	84.8	94.7	93.7
with insulae	0.3	30.2	0.3	8.0	0.3	2.0	0.2	0.2	0.3
ridged	0.0	2.0	0.5	12.0	0.4	2.0	10.0	0.0	0.0
rugulate	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
grooved	0.4	0.3	0.0	2.0	0.0	0.0	0.0	0.0	0.0
smooth	0.0	4.0	0.0	0.0	9.0	18.0	0.0	0.0	0.0
tapered muri	65.8	74.0	60.0	51.9	67.5	85.9	58.1	70.0	60.0
rounded off muri	34.2	26.0	40.0	48.1	32.5	0.6	41.9	30.0	40.0
lumina with regular pits	65.8	66.2	70.0	79.0	76.2	74.0	15.0	56.2	80.0
lumina with irregular pits	0.3	11.0	0.1	5.0	0.3	7.0	35.0	20.0	5.0
lumina with more than one pit	0.2	5.0	10.0	3.0	5.0	2.0	3.0	10.0	10.0
lumina with joined pits	0.7	0.6	0.5	11.0	0.5	6.0	6.0	0.3	5.0
lumina with granular processes	0.2	0.1	5.0	2.0	0.0	11.0	41.0	0.3	0.0
Exine at apocolpium									
similar to exine at mesocolpium	82.7	71.5	75.0	66.0	71.2	85.0	79.0	94.9	70.0
with less raised reticulum	0.4	21.0	15.0	18.0	0.7	7.0	9.0	0.1	10.0
with reduced number of pits	0.3	0.3	10.0	16.0	0.5	8.0	12.0	0.0	10.0
with increased number of pits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exine at furrow margin									
similar to exine at mesocolpium	0.5	16.0	0.0	0.0	0.0	17.0	13.0	20.0	0.0
more finely reticulate	66.7	68.0	25.0	0.1	25.7	50.0	60.0	70.0	55.0
with margo	0.8	16.0	75.0	97.5	74.3	33.0	27.0	10.0	45.0
with reduced number of pits	27.6	50.0	92.0	94.3	91.9	50.0	44.0	57.0	75.0
with increased number of pits	72.4	50.0	8.0	0.2	0.3	50.0	56.0	63.0	25.0
Furrow membrane									
smooth	0.2	18.0	0.0	16.0	0.5	0.8	0.8	0.0	0.0
microgranular	35.5	0.0	50.0	60.2	75.0	60.4	39.6	99.0	1.0
granular	41.0	76.0	0.0	0.8	0.0	0.0	39.6	1.0	99.0
warty	18.0	6.0	50.0	4.0	0.5	0.8	0.0	0.0	0.0
Number of pits at mesocolpium $\cdot \mu\text{m}^{-2}$									
0.8 - 1.6	0.8	0.5	33.3	1.0	0.6	-	-	0.0	25.0
1.7 - 2.4	27.2	0.9	33.4	66.1	53.6	69.0	63.0	0.0	0.0
2.5 - 3.2	1.0	33.0	33.3	10.0	31.9	6.0	-	0.0	50.0
3.3 - 4.1	27.2	0.9	-	-	-	2.0	-	50.0	25.0
4.2 - 4.9	0.1	0.5	-	-	-	23.0	37.0	50.0	0.0

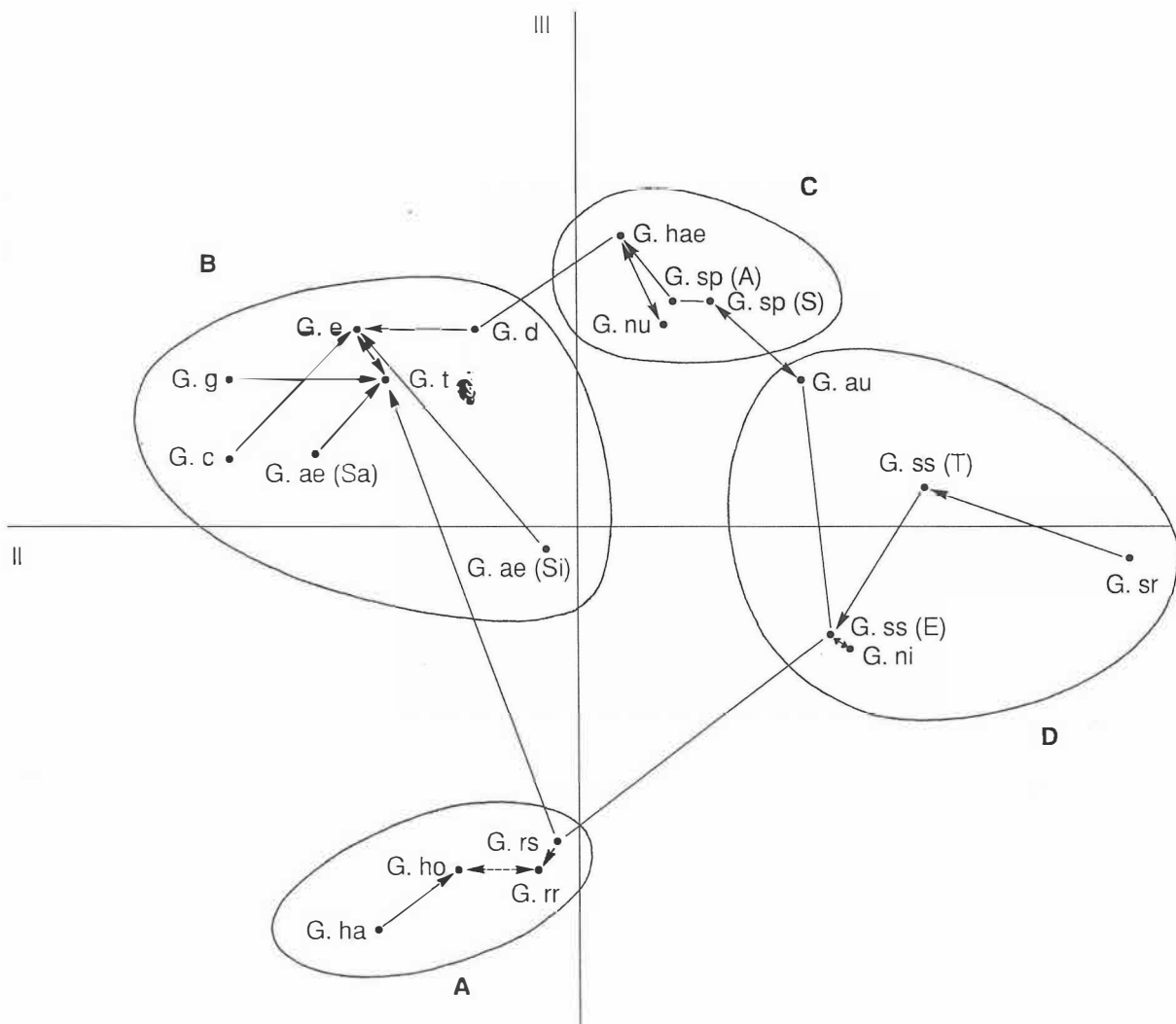


Fig. 5 - Ordination and minimum spanning tree of the taxa of the sect. *Spartocarpus* on the basis of the quantitative and qualitative pollen characters of Tabs. 2-3. Different groups of populations of *Genista radiata*, *G. sessilifolia*, *G. spartioides* and *G. aetnensis* were considered separately. G. ae (Sa) = *G. aetnensis* (Sardinia); G. ae (Si) = *G. aetnensis* (Sicily); G. au = *G. aucheri*; G. c = *G. cilentina*; G. d = *G. dorycnifolia*; G. e = *G. ephedroides*; G. g = *G. gasparrinii*; G. ha = *G. hassertiana*; G. hae = *G. haenseleri*; G. ho = *G. holopetala*; G. ni = *G. nissana*; G. nu = *G. numidica*; G. rr = *G. radiata* var. *radiata*; G. rs = *G. radiata* var. *sericopetala*; G. sr = *G. sessilifolia* ssp. *romanica*; G. ss (E) = *G. sessilifolia* ssp. *sessilifolia* (Europe); G. ss (T) = *G. sessilifolia* ssp. *sessilifolia* (Turkey); G. sp (A) = *G. spartioides* (Africa); G. sp (S) = *G. spartioides* (Spain); G. t = *G. thyrrana*.

distribution, and *G. spartioides* (subcluster C), with which has the closest pollen affinity. Therefore, this species can be considered a link between the eastern racemose species and western ones.

Subcluster C comprises *Genista spartioides*, *G. haenseleri* and, more separated, *G. numidica*, Spanish and north-African species. *G. spartioides* and *G. haenseleri* have the westernmost distribution and display common palynological, morphological (alternate and opposite branches,

unifoliate alternate leaves, flowers in racemes of clusters or rarely in racemes) and karyological characters: $2n = 40$ (Sañudo 1971). As regards *G. spartioides*, the pollen analysis seems to confirm the existence of a subspecific entity in southern Spain. This may correspond to subsp. *retamoides* (Spach) Maire, distinct from the populations of Morocco and Algeria; the systematics of this complex is still uncertain (see Maire 1987, Greuter *et al.* 1989).

Subcluster B comprises the west-Mediterranean species *Genista ephedroides*, *G. thyrrrena*, *G. gasparrinii*, *G. cilentina*, *G. aetnensis* and *G. dorycnifolia*. They all have alternate and subopposite branches, trifoliolate or unifoliolate, often fugacious leaves, more or less lax, many-flowered racemes. The Tyrrhenian species *G. ephedroides*, *G. thyrrrena*, *G. cilentina* and *G. gasparrinii* form a rather compact group also on the basis of their pollen characters. On the contrary, *G. numidica*, an Algerian endemic, included by Gibbs (1966) in *G. ephedroides*, stands well apart from these species as regards its pollen characters and is closer to *G. spartioides* and *G. haenseleri*, forming with them subcluster C. Thus, pollen characters do not support the inclusion of all the Sardinian, Sicilian, north-African and Tyrrhenian taxa in *G. ephedroides*, as proposed by Gibbs (1966); pollen analysis is, instead, more in accord with the arrangement proposed by Greuter *et al.* (1989), who referred *G. ephedroides*, *G. thyrrrena* and *G. gasparrinii* [to which has to be added *G. cilentina*, described later (Valsecchi 1993)] to *G. ephedroides* aggr. and maintained *G. numidica* as separate. Besides, there is a notable karyological homogeneity ($2n = 48$) among *G. ephedroides* (Villa 1980), *G. gasparrinii* (Colombo *et al.* 1979, sub *G. ephedroides*) and *G. cilentina* (Pizzolongo 1960, sub *G. ephedroides*), the only taxa karyologically examined so far. These five species are presumably schizoendemics originating from a common ancestor, as already suggested by De Marco *et al.* (1985). The early geographical isolation, due to the separation of the Sardo-Corsian block from the Alboran-Kabyria tectonic plate in the middle Jurassic, to the following fragmentation and dispersion of the Alboran plate in the period that goes from the Oligocene to the Miocene (Alvarez *et al.* 1974), as well as to the formation of the Liguro-Balearic basin in the upper Oligocene and of the Tyrrhenian basin in the upper Pliocene and in the Quaternary (Dazzaro *et al.* 1984), may be the reason of a morphological and palynological differentiation of the taxa, particularly evident in *G. numidica*.

The Sardo-Sicilian endemic *Genista aetnensis* is fairly close to the species of *G. ephedroides* aggr. not only on the basis of pollen characters, but they also display some significant morphological affinities, particularly as regards the inflorescence. The Sardinian and the Sicilian populations of *G. aetnensis* differ both for their pollen and morphological characters, particularly as regards

the dimensions of the legume. Presl (1844) distinguished the Sardinian and the Sicilian populations, referring them respectively to *Drymospartum sardoum* Presl and to *Drymospartum aetnense* (Biv.-Bern.) Presl. This distinction, though accepted by Spach (1845) under the names *Dendrospartum sardoum* Spach and *Dendrospartum aetnense* Spach, has been subsequently ignored. As regards the range disjunction, Arrigoni & Vannelli (1967) consider paleogeographical links between Sicily and Sardinia as very unlikely, and believe in a more recent arrival and establishment of *G. aetnensis* from Sardinia on the Etna Volcano.

Genista dorycnifolia, a Balearic endemic, displays the highest pollen affinity with *G. aetnensis* (especially with the Sardinian populations) and, through it, with the species of *G. ephedroides* aggr.; therefore it is a link between the Tyrrhenian taxa and the Spanish and north-African species. Furthermore, it is worth noting that the chromosome number of *G. dorycnifolia* is $2n = 48$ (Santos 1944-45; Cardona & Contandriopoulos 1983), the same of the species of *G. ephedroides* aggr. so far examined.

Subclusters A and D are geographically very close, but they are separated and differ in pollen and karyological characters. Subcluster A displays the highest pollen affinity, through *Genista aetnensis*, with subcluster B, including Tyrrhenian species. The two subclusters share the chromosome number $2n = 48$, *G. aetnensis* excluded [$n = 26$ (Forissier 1973), $2n = 52$ (Villa 1988)]. Among the species of subcluster D, only *G. sessilifolia* has been karyologically studied; its chromosome basic number is different from the others, being $2n = 22$ (Kuzmanov 1974; Krusheva 1975).

The two subclusters of the western species (B and C), all racemous, are the closest as regard pollen characters.

Eastern (subclusters A and D) and western species (subclusters B and C) stand well apart. It is worth noting that the distinction we found, based on the pollen analysis, corresponds to the segregation, based on morphological characters, established by Spach (1844) between sect. *Asterospartum* and sect. *Ephedrospartum*. The former section includes all the eastern species of sect. *Spartocarpus* known to him (*Genista radiata*, *G. holopetala*, *G. aucheri*); the latter includes the western species known to him (*G. numidica*, *G. ephedroides*, *G. gasparrinii* and *G. spartioides*), *G. aetnensis* and *G. haenseleri* excluded. As for *G.*

aetnensis, palynological as well as morphological and serological characters (Cristofolini & Feoli Chiapella 1977, 1984) suggest that its allocation to the genus *Dendrospartum*, as proposed by Spach (1845), is unjustified: it seems to be more correct to maintain it in *Genista*. *G. haenseleri* is homogeneous with the other species of sect. *Spartocarpus* also on the basis of its pollen characters. In our opinion its exclusion from *Genista* (Spach 1845) is not justified; it seems to be correct to refer it to sect. *Spartocarpus* as proposed by Gibbs (1966) on morphological basis.

The *Genista radiata* group displays a concentration of characters generally considered derived (opposite branches, opposite leaves, opposite flowers in terminal clusters); alternate branches, alternate leaves, terminal, lax racemes being considered as primitive characters (Polhill 1981). The description of *Cytisanthus*, a genus in which several species of sect. *Spartocarpus* have been included, is based on the characters of the *G. radiata* group. The question whether the section is homogeneous enough and the characters are sufficient to segregate a genus is still controversial. As a matter of fact, these characters are only partially common to all the species of sect. *Spartocarpus*, and not always displayed together. Doubts arise particularly for *G. spartioides* and *G. haenseleri*, whose characters differ more from those of *Cytisanthus*. In order to evaluate, the appropriateness of segregating most of the species of sect. *Spartocarpus* into the genus *Cytisanthus*, further comparisons, on the basis of the pollen characters, are necessary with species of the other sections of subgenus *Spartocarpus* and with taxa representing the other two subgenera *Genista* and *Phyllobotrys*.

Conclusions

The detailed morphometric analysis of the pollen of sect. *Spartocarpus* confirms the main pollen characters already described in other infrageneric taxa of *Genista*.

The quantitative characters observed by LM proved to be the most appropriate to distinguish the taxa of sect. *Spartocarpus*, as already noticed in the *Genista sylvestris* group. The qualitative characters examined by LM are less significant, but nevertheless important in separating some taxa not completely distinguishable on the basis of quantitative characters alone. The qualitative characters observed by SEM seem to be of minor

importance, even though the joint use of the three different groups of characters is the most complete in information.

It has been thus possible to separate all the examined taxa of sect. *Spartocarpus* on the basis of their pollen characters.

Not only are the species of the section palynologically different, but they also are morphologically heterogeneous, particularly those with racemous inflorescence (dense or lax, interrupted or uninterrupted racemes, racemes of clusters, unifoliate or trifoliate leaves, opposite or alternate branching), and karyologically heterogeneous (different basic chromosome numbers: $x = 10, 11, 6$ and/or $12, 13$). The chromosome heterogeneity of *Genista*, due to polyploidy, dispolyploidy and aneuploidy (Sañudo 1979; Verlaque 1988) is already well-known. Though being morphologically and karyologically heterogeneous, the species of sect. *Spartocarpus* are serologically more homogeneous, at least those examined: in fact, the eastern species with racemous inflorescence and the western species *G. spartioides* and *G. haenseleri*, morphologically more separated, were not analysed. It is worth noting, however, that the characters concerning the proteins of the seeds are more conservative than the phenological characters (both macromorphological and palynological).

The pollen characters, the macromorphological, karyological and biogeographical ones appear to be related.

In our opinion, taking into account all the available data, the arrangement proposed by Gibbs (1966), who has grouped all the species treated in this study in sect. *Spartocarpus*, seems to be correct. Even though the species referred by Spach (1844) to sect. *Asterospartum* and *Ephedrospartum* display a certain morphological, palynological and karyological diversity, this diversity is not so strong as to separate two sections, especially because the characters vary continuously. At this stage of the research, even the segregation of *Genista aetnensis* into the sect. *Aureospartum* proposed by Valsecchi (1993) cannot be confirmed on the basis of the pollen characters.

All the taxa of *Genista* sect. *Spartocarpus* may be considered well distinguished on the basis of the palynological analysis. The specific treatment of the taxa of the section in Greuter *et al.* (1989) is, in general terms, confirmed by pollen characters. However, *G. radiata*, *G. holopetala* and *G. hassertiana*, though clearly distinct species, display

such remarkable morphological, palynological and karyological affinities that grouping them together, as proposed in different ways by Buchegger (1812), Spach (1844), Fukarek (1964), Mayer (1970), Pignatti (1982), may be appropriate. As concerns the taxa having their origin in the fragmentation of *G. ephedroides*, it may be correct to set *G. ephedroides*, *G. thyrrina*, *G. gasparrinii* and *G. cilentina* in a group on the basis of their morphological, palynological and karyological affinities. The palynological diversity suggests that *G. numidica*, although presenting morphological similarity with these taxa, should not be included into the *G. ephedroides* group. The status of *G. demarcoi* deserves further studies. Investigations on different basis are to be carried out to solve the problem of the subdivision of *G. sessilifolia* and *G. spartioides* into subspecies.

Genista sect. *Spartocarpus* thus consist of 15 species:

Genista radiata group:

G. radiata (L.) Scop., Fl. Carniol. ed. 2, 2: 51. 1772.

G. holopetala (Koch) Bald. in Mem. R. Acc. Sci. Ist. Bologna ser. 5, 9: 524. 1902.

G. hassertiana (Bald.) Buchegger in Österr. Bot. Z. 62: 416. 1912.

Genista sessilifolia DC., Prodr. 2: 146. 1825.

Genista nissana Petrović, Dodat. Fl. Okol. Niša: 51. 1886.

Genista aucheri Boiss., Diagn. Pl. Orient. 2: 7. 1843.

Genista spartioides Spach in Ann. Sci. Nat. Bot. ser. 3, 2: 243. 1844.

Genista haenseleri Boiss., Elench. Pl. Nov.: 31. 1838.

Genista dorycnifolia Font Quer in Bull. Inst. Catalana Hist. Nat. 20: 46. 1920.

Genista aetnensis (Biv.) DC., Prodr. 2: 150. 1825.

Genista ephedroides group:

G. ephedroides DC., Prodr. 2: 147. 1825.

G. gasparrinii (Guss.) C. Presl, Fl. Sicula: xix. 1826.

G. thyrrina Valsecchi in Boll. Soc. Sarda Sci. Nat. 25: 145. 1986.

G. cilentina Valsecchi in Boll. Soc. Sarda Sci. Nat. 29: 255. 1993.

? *G. demarcoi* Brullo, Scelsi & Siracusa in Flora Mediterranea 3: 304. 1993.

G. numidica Spach in Ann. Sci. Nat. Bot. ser. 3, 2: 244. 1844.

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References

- Accorsi C.A. & Forlani L., 1976. *Schede per una flora palinologica italiana. Contributo n° 4: schede di nuova impostazione*. Arch. Bot. Biogeogr. Ital., 52: 58-111.
- Accorsi C.A., Aiello M., Bandini Mazzanti M., Bertolani Marchetti D., De Leonardis W., Forlani L. & Piccione V., 1983. *Flora palinologica italiana. Schede elaborate tramite computer*. Arch. Bot. Biogeogr. Ital., 59: 55-104.
- Alvarez W., Coccozza T. & Wezel F.C., 1974. *Fragmentation of the Alpine orogenic belt by microplate dispersal*. Nature, 248: 309-314.
- Anderson T.F., 1951. *Techniques for the preservation of the three-dimensional structure in preparing specimens for the electron microscope*. New York Acad. Sci. Trans., 13: 130-134.
- Arrigoni P.V. & Vannelli S., 1967. *La Genista aetnensis (Raf.) DC. in Sardegna*. Webbia, 22 (1): 1-20.
- Bertolani Marchetti D., 1960. *Ricerche sulla vegetazione della Valsesia. IV: Genista radiata (L.) Scop. var. sericopetala Buch. in Valsesia e sua distribuzione geografica*. Webbia, 15 (2): 425-432.
- Bisby F.A., 1981. *Genisteae (Adans.) Benth.* In: Polhill R.M. & Raven P.H. (eds.), *Advances in Legume Systematics*. 1. Royal Bot. Gardens, Kew, 409-425.
- Bisby F.A. & Nicholls K.W., 1977. *Effects of varying character definitions on classification of Genisteae (Leguminosae)*. J. Linn. Soc., Bot., 74 (1): 97-121.
- Brullo S., Scelsi F. & Siracusa G., 1992. *Osservazioni tassonomiche e fitogeografiche su Genista gasparrinii (Guss.) C. Presl endemismo siculo*. Giorn. Bot. Ital., 126 (2): 378.
- Brullo S., Scelsi F. & Siracusa G., 1993. *Genista demarcoi, a new species from Sicily*. Flora Mediterranea 3: 299-307.
- Buchegger J., 1912. *Beitrag zur Systematik von Genista hassertiana, G. holopetala und G. radiata*. Österr. Bot. Z., 62 (1): 303-312, 416-423, 458-465.
- Cardona M.-A. & Contandriopoulos J., 1983. In: *IOPB Chromosome number reports LXXIX*. Taxon, 32 (2): 323-324.
- Colombo P., Marcenò C. & Princiotta R., 1979. *Numeri cromosomici per la Flora Italiana: 662-675*. Inform. Bot. Ital., 11 (3): 315-325.
- Cristofolini G. & Feoli Chiapella L., 1977. *Serological systematics of the tribe Genisteae (Fabaceae)*. Taxon, 26 (1): 43-56.
- Cristofolini G. & Feoli Chiapella L., 1984. *Origin and diversification of Genisteae (Fabaceae): a serosystematic purview*. Webbia, 38: 105-122.
- Cubas P. & Pardo C., 1984. *Morfología y biometría del polen en el género Ulex L. (Genisteae, Papilionoideae)*. In: La Sema Ramos I. (ed.), *Polen y esporas: contribución a su conocimiento*. VIII Simposio de Palinología (A.P.L.E.). Universidad de La Laguna, Tenerife, 19-33.
- Cusma Velari T. & Feoli Chiapella, L. 1987a. *Analisi cariológica e citogeografica di Genista radiata*. Biogeographia, 13: 421-427.

- Cusma Velari T. & Feoli Chiapella L., 1987b. *Nota cariologica su Genista holopetala (Fleischm. ex Koch) Baldacci*. Inform. Bot. Ital., 19 (3): 267-269.
- Cusma Velari T. & Feoli Chiapella L., 1991. *Systematic relationships within the Genista sylvestris group (Genisteae, Fabaceae) on the basis of karyological and biometrical data*. Flora Mediterranea, 1: 21-29.
- Dazzaro L., Palmentola G. & Rapisardi L., 1984. *Linee generali dell'evoluzione paleogeografica dell'Italia meridionale nel quadro delle interazioni fra Africa ed Europa*. Lav. Soc. Ital. Biogeogr., 10: 1-12.
- De Marco G., Altieri A. & Estabrook G.F., 1985. *Relazioni evolutive e biogeografiche dei popolamenti ad areale disgiunto di Genista ephedroides DC.* Biogeographia, 11: 115-131.
- Erdtman G., 1969. *Handbook of palynology*. Munksgaard, Copenhagen, 486 pp.
- Fægri K. & Iversen J., 1964. *Textbook of pollen analysis*. Munksgaard, Copenhagen, 237 pp.
- Faugeras G. & Paris R., 1971. *Nouvelle recherches phytochimiques sur les Papilionacées-Genistées d'Europe*. Boissiera, 19: 210-218.
- Feoli E., Lagonegro M. & Zampar A., 1982. *Classificazione e ordinamento della vegetazione. Metodi e programmi di calcolo*. C.N.R. Collana Programma Finalizzato "Promozione Qualità Ambiente" AQ/5/35, 192pp.
- Feoli Chiapella L., 1982a. *Variabilità pollinica del gruppo di Genista sericea*. Giom. Bot. Ital., 116, suppl. 1: 156-157.
- Feoli Chiapella L., 1982b. *Sistematica palinologica di alcune specie di Genista L., sezione Spartocarpus Spach*. Giom. Bot. Ital., 116, suppl. 1: 158-159.
- Feoli Chiapella L., 1983. *Palynotaxonomic studies on Genisteae. I. Genista germanica L. and the group of G. sylvestris*. Boll. Soc. Adriat. Sci. Nat. Trieste, 67: 25-40.
- Feoli Chiapella L. & Rizzi Longo L., 1984. *Palinotassonomia di Genista L., sect. Spartocarpus con particolare riguardo alle specie occidentali*. Giom. Bot. Ital., 118, suppl. 2: 56-58.
- Feoli Chiapella L. & Rizzi Longo L., 1987. *Distribuzione ed ecologia del genere Genista L. nel Friuli-Venezia Giulia*. Biogeographia, 13: 119-152.
- Ferguson I.K. & Skvarla J.J., 1981. *The pollen morphology of the subfamily Papilionoideae (Leguminosae)*. In: Polhill R.M. & Raven P.H. (eds.), *Advances in Legume Systematics*. 2. Royal Bot. Gardens, Kew, 859-896.
- Fiori A., 1925. *Nuova Flora Analitica d'Italia*. 1. Ricci, Firenze, 801-944.
- Forissier R., 1973. *Recherches cytotoxonomiques préliminaires sur les genres Lembotropis, Cytisus, Chamaecytisus, Genista et Chamaespartium*. Bull. Soc. Neuchâteloise Sci. Nat., 96: 51-65.
- Fukarek P., 1964. *Geobotanička i ekološka istraživanja balkanskih omelika. Vrstje roda Cytisanthus Lang.* Naučno Društvo sr Bosne i Hercegovine, 25, Odjeljenje Privredno-Tehničkih Nauka, Sarajevo, 7: 5-56.
- Gams H., 1923. *Cytisanthus Lang.* In: Hegi G. (ed.), *Illustrierte Flora von Mittel-Europa*. 4 (3). Hanser, München, 1193-1195.
- Ghirardelli L.A., Rizzi Longo L., Feoli Chiapella L. & Calligaris S., 1994. *Ultrastruttura dell'esina di Genista L.* Boll. Soc. Adriat. Sci. Nat. Trieste, 75: 165-183.
- Gibbs P.E., 1966. *A revision of the genus Genista L.* Notes Roy. Bot. Gard. Edinburgh, 27 (1): 11-99.
- Gibbs P.E., 1968. *Genista L.* In: Tutin T.G., Heywood V.H., Burges N.A., Moore D.M., Valentine D.H., Walters S.M. & Webb D.A. (eds.), *Flora Europaea*. 2. Cambridge University Press, Cambridge, 94-100.
- Gibbs P.E., 1970. *Genista L.* In: Davis P.H. (ed.), *Flora of Turkey and the East Aegean Islands*. 3. Edinburgh University Press, Edinburgh, 24-32.
- Gower J.C. & Ross G.J.S., 1969. *Minimum spanning tree and single linkage cluster analysis*. Appl. Stat., 18: 54-64.
- Greuter W., Burdet H.M. & Long G. (eds.), 1989. *Med-checklist*. 4. Conservatoire et Jardin botaniques, Genève, 458 + CXXIX pp.
- Guinet P., 1981. *Comparative Account of Pollen Characters in the Leguminosae*. In: Polhill R.M. & Raven P.H. (eds.), *Advances in Legume Systematics*. 2. Royal Bot. Gardens, Kew, 789-799.
- Hanks S.L. & Fairbrothers D.E., 1976. *Palynotaxonomic investigations of Fagus L. and Nothofagus Bl.: light microscopy, scanning electron microscopy and computer analysis*. Bot. Syst., 1: 1-141.
- Harborne J.B., 1969. *Chemosystematics of the Leguminosae. Flavonoid and isoflavonoid patterns in the tribe Genisteae*. Phytochemistry, 8: 1449-1456.
- Knoche H., 1922. *Flora balearica*. 2. Roumégous et Déhan, Montpellier, 585 pp.
- Krusheva R. M., 1975. In: *IOPB Chromosome number reports L*. Taxon, 24 (5/6): 676-678.
- Kuzmanov B.A., 1974. In: *IOPB Chromosome number reports XLVI*. Taxon, 23 (5/6): 808-809.
- Lagonegro M. & Feoli E., 1981. *SINFUN: a program for information analysis in ecology*. Quaderni Centro Calcolo Univ. Trieste, 16, 11+20 pp.
- Maire R., 1987. *Flore de l'Afrique du Nord*. 16. Lechevalier, Paris, 302 pp.
- Mayer E., 1970. *Zur Kenntnis der Südosteuropäischen Cytisanthus - Sippen*. Glas. Repub. zavoda Žas. Prirode, 3: 37-47.
- Misset M.-T., Gourret J.-P. & Huon A., 1982. *Le pollen d'Ulex L. (Papilionoideae): morphologie des grains et structure de l'exine*. Pollen & Spores, 24 (1): 369-395.
- Pellegrin F., 1908. *Recherches anatomiques sur la classification des Genêts et des Cytises*. Ann. Sci. Nat. Bot., 7: 129-320.
- Pignatti S., 1982. *Flora d'Italia*. 1. Edagricole, Bologna, 790 pp.
- Pizzolongo P., 1960. *Una nuova stazione dell'endemismo tirrenico Genista ephedroides DC. Cenni sulla distribuzione e sulla cariologia*. Delpinoa (n.s.), 2: 79-84.
- Poldini L., 1964. *A proposito del Cytisanthus holopetalus (Fleischm.) Gams*. Pubbl. Ist. Bot. Univ. Trieste, 19: 3-11.
- Polhill R.M., 1976. *Genisteae (Adans) Benth. and related tribes (Leguminosae)*. Bot. Syst., 1: 143-368.
- Polhill R.M., 1981. *Papilionoideae*. In: Polhill R.M. & Raven P.H. (eds.), *Advances in Legume Systematics*. 1. Royal Bot. Gardens, Kew, 191-208.
- Presl K.B., 1844. *Botanische Bemerkungen*. Abh. Böhm. Ges. Wiss., 3: 1-154.
- Quezel P. & Santa S., 1962. *Nouvelle Flore de l'Algérie et des régions désertiques méridionales*. 1. Centre National de la Recherche Scientifique, Paris, 565 pp.
- Rizzi Longo L., 1986. *Tassonomia su basi palinologiche*. Boll. Accad. Gioenia Sci. Nat. Catania, 19: 335-342.
- Rizzi Longo L. & Feoli Chiapella L., 1981a. *Indagine preliminare sui pollini delle Genisteae*. Giom. Bot. Ital., 115 (2/3): 167.
- Rizzi Longo L. & Feoli Chiapella L., 1981b. *Sistematica*

- palinologica del gruppo di Genista sylvestris*. Giorn. Bot. Ital., 115 (6): 416.
- Rizzi Longo L. & Feoli Chiapella L., 1986. *Palynotaxonomy of Genista sericea group*. V Meeting OPTIMA, Istanbul. Abstracts, 78.
- Rizzi Longo L. & Feoli Chiapella L., 1990. *Palynotaxonomy of Genista L. sect. Cephalospartum Spach*. VIII Simposio de Palinologia a.p.l.e., Tenerife. Resúmenes, 100.
- Rizzi Longo L. & Feoli Chiapella L., 1993. *Palynotaxonomy of Genista sericea group*. Proceedings of the OPTIMA V Meeting, Istanbul, 745-760.
- Rizzi Longo L., Feoli Chiapella L. & Piemonte M., 1985. *I pollini di Genista L. sect. Cephalospartum Spach. Indagine preliminare*. Giorn. Bot. Ital., 119, suppl. 2: 148.
- Rizzi Longo L., Feoli Chiapella L. & Rocco G., 1986. *Sistematica su base pollinica del gruppo di Genista albida e di Genista pulchella Vis*. Giorn. Bot. Ital., 120, suppl. 2: 142.
- Rizzi Longo L., Feoli Chiapella L. & Pizzulin Sauli M.L., 1987. *Palynotaxonomy of Genista acanthoclada DC*. I Jornadas de Taxonomía Vegetal, Sevilla. Resúmenes, 6.
- Rizzi Longo L., Feoli Chiapella L. & Pizzulin Sauli M., 1988. *Palynotaxonomical investigations on the Genista acanthoclada group (Genisteae, Fabaceae)*. VII Intern. Palynol. Congress, Brisbane. Symposia Abstracts, 143.
- Santos A.C. dos, 1944-45. *Algumas contagens de cromosomas nos géneros Genista L. e Cytisus L.* Bol. Soc. Brot., 19: 519-522.
- Sañudo A., 1971. *Variabilidad cromosómica de las Genisteas de la Flora Española en relación con su ecología. I. Número y comportamiento de los cromosomas durante la meiosis. A. Secciones Erinacoides Spach, Scorpioides (L.) DC. y Asterospartum Spach del Gen. Genista*. Cuad. C. Biol. Univ. Granada, 1: 5-21.
- Sañudo A., 1979. *Chromosome variability in the Genisteae (Adans.) Benth. (Leguminosae)*. Webbia, 34 (1): 363-408.
- Sneath P.H.A. & Sokal R.R., 1973. *Numerical Taxonomy. The principles and practice of numerical classification*. Freeman, S. Francisco, 573 pp.
- Spach E., 1844. *Revisio generis Genista*. Ann. Sci. Nat. Bot., sér 3, 2: 237-279.
- Spach E., 1845. *Revisio generis Genista (Suite)*. Ann. Sci. Nat. Bot., sér 3, 3: 102-158.
- Strgar V., 1963. *Seseli malyi Kerner tudi na ozemlju Slovenije*. Biol. Vestn., 11: 33-42.
- Strid A., 1986. *Mountain flora of Greece*. 1. Cambridge University Press, Cambridge, 822 + XXX pp.
- Valsecchi F., 1986a. *Due nuove specie del genere Genista L. nel Mediterraneo*. Boll. Soc. Sarda Sci. Nat., 25: 143-147.
- Valsecchi F., 1986b. *Le piante endemiche della Sardegna: 188-189*. Boll. Soc. Sarda Sci. Nat., 25: 193-202.
- Valsecchi F., 1993. *Il genere Genista L. in Italia. I. Le specie delle sezioni Erinacoides Spach, Ephedrospartum Spach, Aureospartum sect. nova*. Webbia, 48: 779-824.
- Van Campo M., 1966. *Variations polliniques intraflorales*. Adansonia (n.s.), 6: 55-64.
- Verlaque R., 1988. *Modalités de la speciation chez les Genisteae*. Act. Simp. Int. Bot. Pius Font i Quer, 2: 49-68.
- Verlaque R., Seidenbinden M. & Reynaud C., 1987. *Recherches cytotaxonomiques sur la speciation en région Méditerranéenne. III: espèces aneuploides*. Rev. Biol. - Ecol. Médit., 10: 315-346.
- Villa R., 1980. *Numeri cromosomici per la Flora Italiana: 733-741*. Inform. Bot. Ital., 12 (2): 155-160.
- Villa R., 1988. *Numeri cromosomici per la Flora Italiana: 1197-1204*. Inform. Bot. Ital., 20 (2/3): 647-652.
- Walker J.W. & Doyle J.A., 1975. *The bases of Angiosperm phylogeny: palynology*. Ann. Missouri Bot. Gard., 62: 664-723.
- Willkomm M., 1880. *Papilionaceae*. In: Willkomm M. & Lange J., *Prodromus Florae Hispanicae*. 3. Schweizerbart, Stuttgartiae, 247-470.
- Zickler D., 1968. *Orophytes endémiques ou rares*. Inf. Ann. Caryosyst. Cytogen., 2: 1-4.

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LE CENOSI A *SCHOENUS NIGRICANS* DEL CARICION DAVALLIANAE KLIKA 1934 NELLA PIANURA PADANA ORIENTALE (VENETO-FRIULI)

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Abstract: THE *SCHOENUS NIGRICANS* COMMUNITIES OF CARICION DAVALLIANAE KLIKA 1934 IN THE EASTERN PO PLAIN (VENETO - FRIULI). The authors give a syntaxonomic revision of the *Schoenus nigricans* communities belonging to the *Caricion davallianae* Klika 1934 in the eastern Po Plain. On the basis of relevés from the literature and of original ones, a single association has been recognized. It joins the *Erucastro-Schoenetum nigricantis* Poldini 1972 and the *Euphrasio marchesettii-Schoenetum nigricantis* Marchiori & Sburlino 1982. The name of this association is *Erucastro-Schoenetum nigricantis* Poldini 1973 em. Sburlino & Ghirelli. Two subassociations have been recognized: *Erucastro-Schoenetum nigricantis typicum* and *Erucastro-Schoenetum nigricantis scorzonetosum humilis* subass. nova.

Introduzione

L'interesse fitogeografico delle cenosi a *Schoenus nigricans* delle torbiere basse neutro-alcaline della Pianura padana orientale è ben noto (Poldini 1973; Marchiori *et al.*, 1980; Martini & Poldini 1986): ospitano infatti un notevole contingente di entità microterme con carattere di relitti glaciali, unitamente ad alcuni endemismi locali ad esse ecologicamente legati. A ciò si aggiunge il fatto che si tratta di ambienti ormai in via di scomparsa.

Da un punto di vista fitosociologico, se il settore friulano in provincia di Udine si può ritenere indagato nel suo complesso (Poldini 1973; Marchiori & Sburlino 1982), altrettanto non si può dire per il Veneto: i pochi dati reperibili provengono infatti solo da una ristretta area del padovano (Marchiori *et al.* 1980). Per questo motivo recentemente, da parte degli scriventi, sono stati effettuati alcuni rilevamenti anche in altre località delle risorgive venete e del settore friulano-veneto in destra del Tagliamento (PN) del quale finora non era disponibile alcun dato bibliografico. Sulla base dei dati di letteratura e dei rilievi

originali, si è ritenuto quindi opportuno effettuare una revisione sintassonomica di queste cenosi.

Gli autori precedentemente citati hanno descritto o riconosciuto nel territorio in esame le seguenti associazioni: *Erucastro-Schoenetum nigricantis* Poldini 1972 (risorgive friulane in sinistra del Tagliamento - UD); *Euphrasio marchesettii-Schoenetum nigricantis* Marchiori e Sburlino 1982 (anfiteatro morenico del Tagliamento - UD); *Orchio-Schoenetum nigricantis* Oberd. 1957 (risorgive del F. Tergola - PD).

Sia Poldini (1973) che Marchiori & Sburlino (1982) sottolineano l'indipendenza floristico-fitogeografica delle cenosi a *Schoenus nigricans* della Pianura friulana dai sintipi centroeuropei (*Orchio-Schoenetum nigricantis* Oberd. 1957 e *Primulo-Schoenetum ferruginei* [Koch 1926] Oberd. 1957 em. 1962). Le specie proposte come caratteristiche sono in entrambi i casi endemiche: a carattere locale per l'*Erucastro-Schoenetum* (*Erucastrum palustre*, *Centaurea forojuliensis*, *Armeria helodes*), a carattere padano per l'*Euphrasio-Schoenetum* (*Euphrasia marchesettii*).

Dati e metodi

I complessivi 29 rilievi riportati in Tab.1 sono stati sottoposti a processi di classificazione numerica. Sulla tabella opportunamente trasformata secondo i dati di presenza/assenza è stata costruita una matrice di somiglianza utilizzando come coefficiente la distanza della corda. L'algoritmo utilizzato per la classificazione è quello che misura la varianza all'interno dei gruppi formati (SSA o "Sum of Squares Agglomeration"). I programmi usati fanno parte del package SYN-TAX IV (Podani 1990). Per l'elaborazione non sono state utilizzate le specie appartenenti alla I classe di presenza. La sequenza dei rilievi della tabella rispecchia quella ottenuta con la classificazione gerarchica.

La nomenclatura tassonomica corrisponde a quella di Pignatti (1982) con le eccezioni di *Armeria helodes* e *Centaurea nigrescens* ssp. *vochinensis*, per le quali si sono seguiti rispettivamente Martini & Poldini (1987) ed Ehrendorfer (1973).

Risultati e Discussione

La classificazione evidenzia due gruppi principali (Fig. 1). Il gruppo A comprende i rilievi dell'*Erucastro-Schoenetum* di Poldini (1973), due rilievi di Feoli & Cusma (1974) dell'alta e bassa Pianura friulana senza chiara attribuzione fitosociologica, i rilievi di Marchiori *et al.* (1980) riferiti all'*Orchio-Schoenetum* e altri inediti provenienti anch'essi dalla Pianura veneta (PD-TV). Il gruppo B comprende quelli dell'*Euphrasio-Schoenetum* di Marchiori & Sburlino (1982) e alcuni altri inediti delle risorgive friulane (UD) e friulano-venete (PN).

La classificazione non evidenzia quindi una distinzione geografica dei rilievi e, conseguentemente, dei diversi tipi proposti; in particolare i rilievi veneti presentano maggiori affinità con quelli originali dell'*Erucastro-Schoenetum* delle risorgive friulane, mentre quelli inediti provenienti da quest'ultimo settore geografico risultano legati all'*Euphrasio-Schoenetum* dell'alta Pianura friulana.

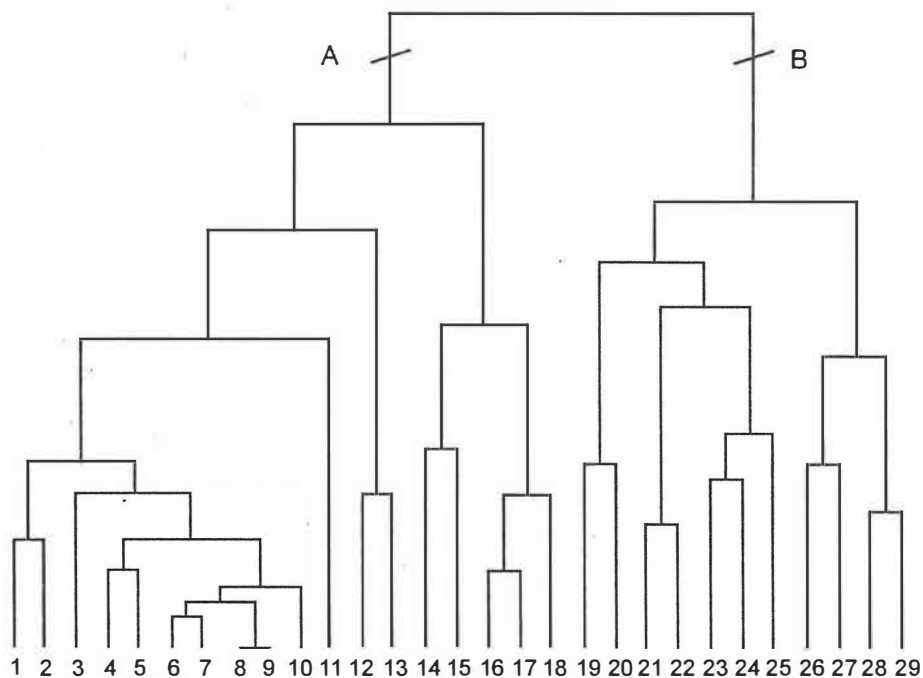


Fig. 1 - Dendrogramma di classificazione dei rilievi di Tab. 1. Con A e B sono indicati i gruppi a cui si fa riferimento nel testo
Classification of the relevés of Tab. 1. A, B: groups of relevés as in the main text.

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Questo fatto, di per se stesso, non sembra giustificare l'attribuzione degli individui d'associazione a tipi fitosociologicamente diversi. Infatti, per le ragioni suddette, non sembra essere sostenibile l'esistenza di due distinte associazioni entrambe endemiche di ristretti settori della stessa area geografica (*Erucastro-Schoenetum* ed *Euphrasio-Schoenetum*).

Per quanto riguarda gli individui veneti, una loro attribuzione all'*Orchio-Schoenetum* potrebbe essere sostenuta solo sulla base della presenza di *Spiranthes aestivalis*, fatto d'altronde comune anche ai rilievi del Friuli. E' infatti assente *Orchis palustris*, l'altra entità considerata come caratteristica di questa associazione, che vi è sostituita dall'affine *O. laxiflora* a carattere più marcatamente mediterraneo (Meusel *et al.* 1965; Poldini 1965). La presenza in questi rilievi di diverse entità a carattere meridionale (*Holoschoenus vulgaris*, *Senecio doria*, *Galium mollugo*, la stessa *Orchis laxiflora*, ecc.), conferma piuttosto l'indipendenza anche delle cenosi venete dalle corrispondenti medio-europee e la loro stretta correlazione fitogeografica con quelle friulane, come d'altronde evidenziato dalla classificazione.

Quest'ultima mette in evidenza due situazioni ecologicamente differenziate all'interno di quello che appare come un unico *syntaxon*.

Il primo gruppo (A: rill. 1-18) corrisponde agli aspetti più umidi e naturali, solo localmente e in modo sporadico sottoposti ad azione antropica (incendio durante il periodo invernale). Vi è esclusivo *Senecio doria* e frequente *Cladium mariscus*, indicante gli stretti rapporti dinamici e spaziali con il *Cladietum marisci* All. 1922 che si sviluppa in corrispondenza delle "polle" di risorgiva. Le specie dei *Molinietalia* W. Koch 1926 vi sono in genere scarsamente rappresentate (mediamente 4,6 per rilievo) ed è significativo osservare che quelle a più alta frequenza (*Equisetum palustre*, *Valeriana dioica* e *Cirsium oleraceum*) sono tra le più esigenti in umidità di quest'ordine (Landolt 1977). Le situazioni più oligotrofiche (rill. 1-10) corrispondono ai rilievi originali dell'*Erucastro-Schoenetum* di Poldini (1973); si differenziano per la presenza delle endemiche locali già citate, unitamente a *Sesleria uliginosa* e a *Drosera rotundifolia* (Poldini 1977; Martini & Poldini 1986), quest'ultima presente un tempo anche nelle cenosi a *Schoenus nigricans* del Veneto (Beguinet 1911a,b) ma non più ritrovata recentemente.

Nel secondo gruppo (B: rill. 19-29) sono invece riconoscibili gli aspetti relativamente meno umidi e soggetti allo stesso tipo di trattamento antropico ma che qui assume carattere di maggiore regolarità. Vi si rileva infatti mediamente un maggior numero di specie dei *Molinietalia* (6,3 per rilievo); in particolare la presenza in alcuni casi di *Plantago altissima* e/o *Laserpitium prutenicum*, testimonia i rapporti di queste cenosi con l'associazione a *Molinia caerulea* presente in quest'area geografica [*Plantagini altissimae-Molinietum caeruleae* (Pign. 1953) Marchiori & Sburlino 1982]. Vi sono inoltre più rappresentate od esclusive specie tipicamente prative (*Leontodon hispidus*, *Prunella vulgaris*, *Koeleria pyramidata*, *Leucanthemum vulgare*, ecc.). Significativa è l'alta frequenza di *Carex hostiana*, entità propria degli aspetti maggiormente eutrofici delle torbiere basse neutro-alcaline (Oberdorfer, 1990).

Sulla base di queste considerazioni si ritiene di poter inquadrare tutte le cenosi a *Schoenus nigricans* considerate in un'unica associazione endemica, avente come specie caratteristiche *Euphrasia marchesettii* e, con valore parziale (*sensu* Mucina *et al.* 1993), *Centaurea forojulensis*, *Erucastum palustre* e *Armeria helodes*. Tra le entità a carattere meridionale *Holoschoenus vulgaris* è stato scelto come differenziale d'associazione rispetto ai sintipi centroeuropei, per la sua alta frequenza nei rilievi. L'associazione riunisce l'*Erucastro-Schoenetum nigricantis* Poldini 1972 e l'*Euphrasio marchesettii-Schoenetum nigricantis* Marchiori & Sburlino 1982: sulla base degli artt. 1, 25 e 47 (racc. A) del Codice di Nomenclatura Fitosociologica (Barkman *et al.* 1986) essa va indicata come:

Erucastro-Schoenetum nigricantis Poldini 1973 em. Sburlino & Ghirelli, *hoc loco*

Syn.: *Erucastro - Schoenetum nigricantis* Poldini 1972, *Euphrasio marchesettii - Schoenetum nigricantis* Marchiori & Sburlino 1982

Tipo nomenclaturale: Poldini (1973), Tab. 1, ril. 6 (lectotypus *hoc loco*).

L'associazione si inquadra nell'alleanza *Caricion davallianae* Klika 1934, ordine *Caricetalia davallianae* Br.-B. 1949, classe *Scheuchzerio-Caricetea fuscae* (Nordh. 1936) Tx. 1937. Al suo interno sono riconoscibili due subassociazioni, corrispondenti ai due gruppi evidenziati dalla classificazione gerarchica:

a) *Erucastro-Schoenetum nigricantis typicum* (rill. 1-18)

Tipo nomenclaturale: quello dell'associazione.
Specie differenziali: *Senecio doria*, *Equisetum palustre*, *Cladium mariscus*.

b) *Erucastro - Schoenetum nigricantis scorzonetosum humilis* subass. nova (rill. 19-29)

Tipo nomenclaturale: Tab. 1, ril. 28 (holotypus hoc loco).

Specie differenziali: *Scorzonera humilis*, *Carex hostiana*.

La presenza all'interno dell'*Erucastro-Schoenetum* di entità endemiche esclusive, di specie microterme a gravitazione nordica e di altre a carattere meridionale, conferisce a quest'associazione caratteri di notevole originalità rispetto alle altre conosciute del *Caricion davallianae*. Si tratta a tutti gli effetti di un'associazione di elevatissimo pregio naturalistico, per la cui conservazione si impone in tempi brevi la tutela degli ultimi lembi di territorio nei quali essa è ancora presente.

Appendice 1

Rill. 1-10: rilievi di tab. 1 in Poldini (1973); ril. 11: sorgenti del F. Sile presso Torreselle (Piombino Dese, PD), 25 m, 26.06.993; rill. 12-13: rilievi di tab. 1 in Feoli & Cusma (1974); ril. 14: Palude di Onara (Tombolo, PD), 30 m, 01.08.993; ril. 15: sorgenti del F. Sile presso Casacorba (Veduggio, TV), 30 m, 08.07.993; Rill. 16-17: rill. 1-2 di tab. 1 in Marchiori *et al.* (1980); ril. 18: Palude di Onara (Tombolo, PD), 30 m, 05.06.983; ril. 19: risorgive in loc. "Pasc" presso Cordenons (PN), 40 m, 07.07.993; Rill. 20. 22-29: rill. 1-9 di tab. 1 in Marchiori & Sburlino (1982); ril. 21: risorgive presso Sterpo (Bertiolo, UD), 15 m, 07.07.993.

Appendice 2

Specie sporadiche - ril. 6: *Oenanthe lachenalii*; ril. 7: *Symphytum officinale*; ril. 8: *Symphytum officinale*, *Oenanthe lachenalii*; ril. 10: *Symphytum officinale*, *Oenanthe lachenalii*, *Allium carinatum*, *Lythrum salicaria*, *Carex distans*; ril. 11: *Briza media*, *Lotus corniculatus*, *Lysimachia vulgaris*, *Frangula alnus* (1), *Centaurea nigrescens* ssp. *vochinensis*, *Senecio paludosus*, *Dactylis glomerata*, *Festuca tenuifolia*; ril. 12: *Centaureum erythraea*, *Anthericum ramosum*, *Buphtalmum salicifolium*; ril. 13: *Hypochoeris maculata*; ril. 14: *Equisetum hyemale*, *Briza media*, *Lotus corniculatus*, *Centaureum erythraea*, *Equisetum fluviatile* (1), *Carex elata*; ril. 15: *Briza media*, *Lysimachia vulgaris*, *Centaureum erythraea*, *Frangula alnus*, *Centaurea nigrescens* ssp. *vochinensis*, *Equisetum telmateja*, *Senecio paludosus*, *Holcus lanatus*, *Erigeron annuus*; ril. 16: *Orchis laxiflora*, *Frangula alnus*, *Carex flacca*, *Carex umbrosa*, *Ranunculus lanuginosus*; ril. 17: *Briza media*, *Orchis laxiflora*, *Carex flacca*, *Equisetum telmateja*, *Carex umbrosa*, *Alnus glutinosa* (1); ril. 18: *Lysimachia vulgaris*, *Orchis laxiflora*, *Equisetum fluviatile*, *Listera ovata*; ril. 19: *Equisetum hyemale*, *Briza media*, *Carex flacca*, *Koeleria pyramidata*, *Leucanthemum*

vulgare; ril. 20: *Equisetum hyemale*, *Schoenoplectus americanus*; ril. 21: *Equisetum hyemale*, *Centaureum erythraea*, *Dactylis glomerata* (1), *Koeleria pyramidata* (1), *Carex caryophylla* (1), *Centaurea jacea*; ril. 22: *Equisetum hyemale*, *Lysimachia vulgaris*, *Schoenoplectus americanus*, *Anthericum ramosum*; ril. 23: *Lotus corniculatus*, *Gentianella germanica*; ril. 24: *Alnus incana* pl.; ril. 25: *Gentianella germanica*; ril. 28: *Lotus corniculatus*, *Gentianella germanica*, *Carex hirta*; ril. 29: *Lotus corniculatus*, *Centaurea nigrescens* ssp. *vochinensis*, *Leucanthemum vulgare*, *Koeleria macrantha*.

Riassunto

Il presente lavoro consiste in una revisione sintassonomica delle cenosi a *Schoenus nigricans* L. del *Caricion davallianae* Klika 1934, presenti nella Pianura padana orientale. Sulla base dei rilievi reperibili in letteratura e di altri inediti, viene riconosciuta un'unica associazione che riunisce l'*Erucastro-Schoenetum nigricantis* Poldini 1972 e l'*Euphrasio marchesettii-Schoenetum nigricantis* Marchiori e Sburlino 1982. Essa va indicata come *Erucastro-Schoenetum nigricantis* Poldini 1973 em.. Nel suo ambito vengono distinte due subassociazioni: *Erucastro-Schoenetum nigricantis typicum* ed *Erucastro-Schoenetum nigricantis scorzonetosum humilis* subass. nova.

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Bibliografia

- Barkman J.J., Moravec J. & Rauschert S., 1986. *Code of Phytosociological Nomenclature*. Vegetatio, 67: 145-195.
Beguinot A., 1911a. *Flora Padovana*. 2(2): 409-608. Tip. Seminario, Padova.
Beguinot A., 1911b. *Le colonie di piante microterme nei terreni torbosi della Provincia di Padova*. N. Giom. Bot. Ital., 18(3): 354-378.
Ehrendorfer F., 1973. *Liste der Gefäßpflanzen Mitteleuropas*. Fischer, Stuttgart.
Feoli E., Cusma T., 1974. *Sulla posizione sistematica di Euphrasia marchesettii Wettst.* Giom. Bot. Ital., 108(3-4): 145-154.
Landolt E., 1977. *Ökologische Zeigerwerte zur Schweizer Flora*. Veröff. Geobot. Inst. Rübel, 64: 1-208.
Marchiori S. & Sburlino G., 1982. *I prati umidi dell'anfiteatro morenico del Tagliamento (Friuli - Italia nord-orientale)*. Doc. Phytosoc., n.s., 7: 199-222.
Marchiori S., Tomadore Marchiori N. & Reffo T., 1980. *La vegetazione della palude relitta di Onara (Tombolo, PD) - I contributo*. Atti V Conv. Gr. "G. Gadio": 117-128.
Martini F. & Poldini L., 1986. *Distribuzione ed ecologia di Erucastrium palustre (Pir.) Vis. Gortania*, 8: 221-242.
Martini F. & Poldini L., 1987. *Ammeria helodes, a new species from North-Eastern Italy*. Candollea, 42: 533-544.
Meusel H., Jäger E. & Weinert E., 1965. *Vergleichende Chorologie der zentraleuropäischen Flora*. G. Fischer, Jena.

- Mucina L., Grabherr G. & Ellmauer T., 1993. *Die Pflanzengesellschaften Österreichs. 1 (Anthropogene Vegetation)*. Fischer, Jena.
- Oberdorfer E., 1990. *Pflanzensoziologische Exkursions Flora*. E. Ulmer, Stuttgart.
- Pignatti S., 1982. *Flora d'Italia*. Edagricole, Bologna.
- Podani J., 1990. *Syn-Tax IV*. UNIDO, Trieste.
- Poldini L., 1965. *Contributo alla flora triestina*. Atti Mus. Civ. St. Nat. Trieste, 24(5): 181-198.
- Poldini L., 1973. *Die Pflanzendecke der Kalkflachmoore in Friaul (Nordostitalien)*. Veröff. Geobot. Inst. Rübel, 51: 166-178.
- Poldini L., 1977. *Centaurea forojuliensis, della sect. Jacea DC. s.str., nuova entità del Friuli*. Giorn. Bot. Ital., 111: 303-309.

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